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Cycling in New York, London, Paris, and Berlin before, during, and after the COVID-19 pandemic

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ABSTRACT

This paper compares trends in cycling levels, cyclist demographics and cycling injury risk in New York, London, Paris and Berlin, before and after the COVID pandemic. We explore these trends in the context of changes to policy and infrastructure before, during, and after COVID. We based our analysis on data from published reports, open-data portals, government websites, travel surveys, and information provided by transport planners in each city. Cycling levels in NYC, London, Paris, and Berlin increased over the three decades prior to COVID (1990–2019). As a percentage of daily trips, bike mode share rose from 0.6% to 2.2% in New York, from 1.2% to 3.7% in London, from 0.4% to 5% in Paris, and from 7% to 18% in Berlin. Cycling rates have continued to increase since COVID. By 2023, bike mode shares had risen further to 3% in NYC, 4.5% in London, 11% in Paris, and 19% in Berlin. Cycling became safer in all four cities over the period 2005 to 2023, with declining per-trip fatality and injury rates. More and better cycling infrastructure has been a cornerstone of pro-cycling efforts, especially cycleways separated from motor vehicle traffic (protected bike lanes). Bike parking and bikesharing systems have expanded and improved. Car restrictions and traffic calming have complemented pro-bike measures, for example, using infrastructure and enforcement to reduce traffic volumes and speeds in residential neighborhoods. Long-term political support as well as cycling advocacy organizations have been critical to the introduction and continuation of pro-bike policies and the necessary financial investments.

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1. Introduction

New York, London, Paris, and Berlin are important economic, cultural, political, and media centers, often setting trends that spread to other cities and countries. In recent decades, all four cities have increased cycling levels while improving cycling safety. Analysis of their successes and challenges in raising cycling levels may help other cities around the world to increase the sustainability of their transport systems by reducing their dependence on motor vehicles. Shifting some car trips to cycling has the potential to reduce air and noise pollution, energy use, and roadway congestion, while increased cycling provides public health benefits from increased physical activity (Buehler & Pucher, 2021a; Celis-Morales et al., 2017; Garrard, Rissel, et al., 2021; Handy, 2023; Heinen & Gotschi, 2022; Hou et al., 2025; Newman & Kenworthy, 2015; Pucher, Parkin, et al., 2021).

The increased importance of cycling in New York, London, and Paris has been remarkable because, in the latter half of the twentieth century, cycling was a minor component of their transport systems. Indeed, in 1990, cycling

accounted for only 0.6% of daily trips in New York, 1.2% in London, and 0.4% in Paris (Pucher, Parkin, et al., 2021). However, as documented in this study, since roughly the year 2000, the three cities have implemented a range of pro-bike measures that have increased cycling levels and improved cycling safety. By 2019, just before the COVID-19 pandemic, cycling rates had risen to 2.2% in New York, 3.7% in London, and 5.0% in Paris. Although Berlin traditionally had more cycling than the other three cities, cycling levels there have also increased significantly in recent decades. In 1985, cycling accounted for 5% of trips in West Berlin and 3% in East Berlin (Kalender, 2012). In 1992, 7% of all trips were made by bicycle in the reunified Berlin (as of 1990). By 2018, 18% of trips in Berlin were made by bicycle, one of the highest bike mode shares among large European cities.

All four cities were profoundly affected by the COVID pandemic. Through 2023, there had been 47,000 deaths in New York (5.7 per 1000 residents) (NYCDOH, 2025); 22,000 deaths in Greater London (2.5 per 1000) (ONS, 2023); 29,000 deaths in the Île de France, Paris's

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metropolitan region (2.4 per 1000) (GEODES, 2024); and 6400 in Berlin (1.7 per 1000) (Pätzold et al., 2025). Paris, London, and Berlin instituted lockdown and closure policies during COVID peaks, greatly reducing travel. New York did not impose lockdowns, but most workplaces, schools, stores and public facilities were closed during COVID peaks, and large public gatherings were banned. All four cities strongly discouraged non-essential travel, especially by public transport.

The pandemic greatly altered travel behavior and increased cycling levels in many cities, especially in 2020 and 2021, when COVID rates were highest (Buehler & Pucher, 2022). Some cities with increased cycling during COVID experienced decreased cycling in 2022 and 2023, after most COVID travel restrictions were lifted. That might have been due to the rebound of car traffic to pre-COVID levels (increasing the risk of cycling on shared streets); elimination or reduction of pro-cycling, car-restrictive measures (e.g. car-free streets, street narrowing, pop-up bike lanes); partial recovery of public transport, re-opening of indoor exercise facilities (e.g. gyms and swimming pools); and persistence of some degree of remote working, shopping, education, and socializing from home (Buehler & Pucher, 2022; Moran, 2022; Morris et al., 2025).

In New York, London, Paris and Berlin, however, cycling levels have continued to increase in the years since the lifting of COVID restrictions. In this paper, we document policies implemented in the four cities that have facilitated the continued growth of cycling—in contrast to many other cities where cycling has stagnated or declined. For instance, in England as a whole—where pro-cycling policies have lagged far behind London—cycling levels flatlined or even declined somewhat over the past decade (2014–2024), except for increases during the COVID years 2020 and 2021. To provide a longer-term perspective, and to place the COVID era in context, we portray trends in cycling levels, cycling safety, and government policies during the years 2000–2019 compared to the years since COVID emerged in Europe and North America in early 2020.

1.1. Research questions

We focus on answering the following research questions for each of the four cities, highlighting the differences between them:

- What were trends in cycling levels in the years before COVID (1990–2019) and since COVID (2022–2025)?
- What have been the trends in cyclist safety over time, measured as fatalities and serious injuries relative to the number of bike trips? How did cycling safety rates after COVID compare with rates before COVID?
- What government policies and infrastructure provision may have encouraged the growth of cycling, while improving cycling safety, before, during, and after the COVID pandemic, and in particular, what new measures were introduced in each city during and since COVID?
- What lessons do the four cities have for other cities trying to encourage more and safer cycling?

1.2. Data and methods

We used data from published reports, open-data portals, government websites, travel surveys, and other documents from each city. In some instances, we used national, state, or regional government data specific to the four cities, such as national censuses, travel surveys, and roadway-safety databases. We supplemented publicly-available data with site visits, in-person and video or telephone conversations, and email exchanges with bicycle planners, academics, and cycling advocates from each city, who answered specific questions and provided unpublished data and planning documents. We identified informants for each city through professional networks, prior research connections, and names listed on websites for specific planning topics or datasets.

To compare cycling in the four cities, we developed indicators for cycling levels, cyclist safety, and cycling policies. The selection of indicators was based on previous research identified in the literature as well as data availability and comparability. For each indicator, we assessed comparability in measurement over time within each city and between cities, highlighting differences that affect our analysis. We also explain the method used to calculate each indicator throughout the text.

In spite of efforts to ensure comparability of data, some of our data are not comparable among cities and over time, as we note throughout the text. We mitigated comparability problems by relying on the following six criteria when collecting data. First, we used official government data wherever possible. Those data are often curated by city governments and undergo regular quality checks. In some cases, city governments maintain datasets based on similar data collection methods over many years. For example, several years of trend data in bicycle mode shares over time in Berlin rely on data from the same survey that collects data for travel behavior in German cities since the 1970s (called SrV). Similarly, Transport for London provides time-series data about the number of bicycle trips, and New York City maintains an online database of bicycle counts over time. Second, wherever possible we used multiple official data sources to corroborate trends based on various indicators. For example, we tracked trends in bicycling levels based on bicycle mode shares from travel surveys, but also bicycle trip volumes based on bicycle counts. Third, to facilitate comparison between cities and over time, we adjusted indicators (such as bicycle trip volumes) for population growth by using per capita numbers.

Fourth, to control for annual variability in some indicators, we analyzed multi-year averages. For example, to control for variability in annual fatality and injury data, we used 3-year averages for fatality and injury rates to account for fluctuations (2004–2006, 2009–2011, 2017–2019, 2022–2024). We took special care to account for the COVID pandemic. For example, for 2019, the last year before COVID, we used the years 2017–2019 to avoid overlap with years during COVID. Fifth, to control for differences in data collection methods between cities, we indexed some indicators to 100% in the first year of data to facilitate comparison between cities and to focus the analysis on trends within

each city. This was the case, for example, for serious injury data, where definitions vary between cities. Sixth, we used spatially disaggregated GIS data from local, regional, or national governments to assess the spatial variability of cycling rates within each city. Although the types of GIS data varied among cities, the GIS maps allowed us to compare the overall patterns of spatial variability in cycling rates among cities.

Our intent was to reduce the extent to which data differences affect our cross-city analyses of trends in cycling. In exploring policy factors that encouraged increased and safer cycling, we conduct a narrative analysis based on expert opinion—our own and that of city stakeholders (government planners and transport experts). Our analysis of policies and interventions is not a trend comparison in the same way as is possible with cycle counts, travel surveys, and injury data. Rather, it represents an informed synthesis of how we and city planners interpret the successes at increasing cycling in terms of the policy factors that have probably helped shape these outcomes.

2. Cycling levels

2.1. Background information on the four cities

As shown in Table 1, there are considerable differences among the four cities in their populations and geographic areas, mostly deriving from differences in the demarcations of political jurisdictions. The City of Paris has the smallest land area, less than an eighth of the land areas of Berlin, New York, and London. That helps explain Paris' smaller population and much higher population density compared to the other cities. Moreover, the City of Paris's population accounts for only 17% of its metropolitan area (Ile de France), compared to 43% for New York, 60% for London and 79% for Berlin, respectively. In that respect, Paris is more comparable to central portions of New York and London. Berlin is a special case: from 1961 to 1989, West Berlin was hemmed in by the Berlin Wall, making suburbanization impossible and facilitating compact development. There was some suburbanization from East Berlin into adjacent portions of East Germany, but limited due to total government control of new land-use development—which was compact and transit-oriented—and low levels of income, car ownership, and home ownership. Despite these differences, we focus our analysis on the cities as officially defined (rather than metropolitan regions) because most local transport planning and policy is determined within municipal political jurisdictions, and most cycling data are based on those jurisdictions. The concentration of universities in city centers may help explain why Paris has higher percentages of university students and of households without cars, as shown in Table 1.

Studies suggest that differences in climate can affect levels of cycling (Goldmann & Wessel, 2021; Heinen et al., 2010). In that respect, New York appears to have the least favorable conditions, with almost twice as much average annual precipitation as the other three cities, as well as hotter summers and colder winters, all of which deter cycling. For example,

Table 1. Demographic and climate information.

		New York	London	Paris	Berlin
Population (million)	<i>City</i>	8.3	8.9	2.1	3.8
	<i>Metro</i>	19.5	14.9	12.3	4.8
Land area (km ²)	<i>City</i>	1224	1572	105	891
	<i>Metro</i>	21,482	8917	12,011	3779
Population per km ²	<i>City</i>	11,314	5640	20,983	4112
	<i>Metro</i>	908	1671	1024	1270
% Univ. Students	<i>City</i>	7	6	10	6
% Car-free Households	<i>City</i>	54	46	66	44
Average Annual Precipitation (cm)		127	58	64	57
Average Days per Year $\leq 0^\circ$ C		81	29	18	80
Average Days per Year $\geq 30^\circ$ C		16	5	14	7

Note. Precipitation and temperatures are based on the most recent 30-year long-term averages.

Sources.: Data collected by the authors for each city.

New York (16) and Paris (14) average far more days than London (5) and Berlin (7) when the high temperature is 30 C or higher. In addition, New York (81) and Berlin (80) average far more days than London (29) and Paris (18) when the low temperature is 0 C or lower. All four cities contain a few hilly districts, but in general, their topography is flat and thus conducive to cycling. All four are traversed by rivers that interrupt the contiguity of the land mass, funneling traffic over bridges or through tunnels. Topographical discontinuity is most extreme in New York, which features several large rivers, bays, sounds, and a large harbor. Indeed, two of the five boroughs of New York City are islands, including Manhattan, the core of the city. In short, New York has more climatic and topographical features that would tend to discourage cycling, perhaps contributing to its lower cycling rate than the other three cities.

2.2. Changes in cycling rates in the four cities from 1990 to 2023

As shown in Figure 1, the cycling mode share of trips increased greatly in all four cities during the period before COVID (1990–1993 to 2017–2019): from 0.4% to 5% in Paris, from 1.2% to 3.7% in London, from 0.6% to 2.2% in NYC, and from 7% to 18% in Berlin, which had, by far, the highest bike mode share of any of the cities throughout the period. The rate of increase was highest in Paris, however, with a 12-fold increase compared to a doubling in Berlin. All four cities further increased the bike mode share of trips during and since COVID (2022–2023 compared to 2017–2019): from 5% to 11% in Paris (more than doubling), from 3.7% to 4.5% in London (by a fifth), from 2.2% to 3% in NYC (by a third), and from 18% to 19% in Berlin (by a twentieth). The largest increase was in Paris, in both relative and absolute terms. The relative increases in London and NYC were larger than in Berlin, but the absolute increase in mode share was slightly larger in Berlin. As noted by Koglin et al. (2021), it is quite difficult to increase bike mode shares from already high levels, such as in Amsterdam and Copenhagen. Thus, the continuing increase in bike mode share in Berlin is impressive. Figure 1 shows that all four cities raised their cycling levels prior to COVID and increased them further during and after COVID.

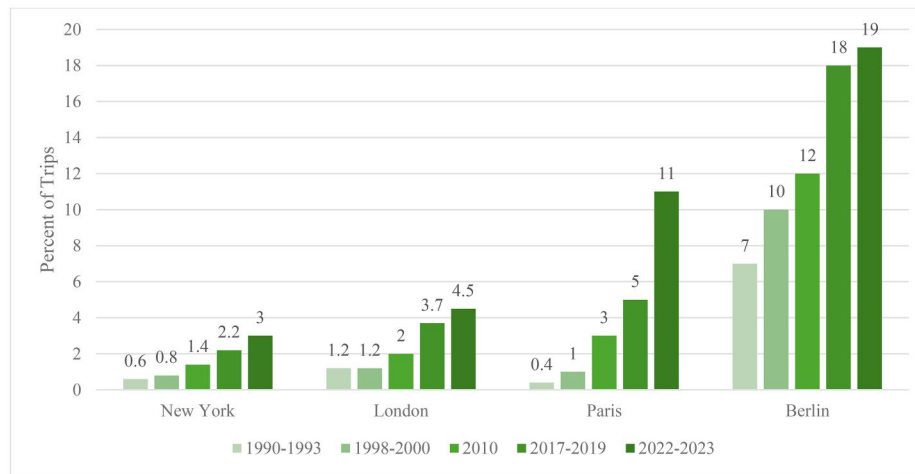


Figure 1. Bicycle share of trips in New York City, London, Paris, and Berlin, 1990–2023. *Note: the actual years vary slightly by city, as follows: New York: 1990, 2000, 2010, 2019, 2022; London: 1993, 2000, 2010, 2019, 2022; Paris: 1990, 2000, 2010, 2017, 2023; Berlin: 1992, 1998, 2010, 2018, 2023. The percentages shown in the graphic refer to the bicycle share of all trips, all trip purposes, based on travel surveys for each city. Sources: City of Paris, 2000–2023; City of Berlin, 2003–2025; Kalender, 2012; NYCDOT, 2018–2023; Pucher, Parkin, et al., 2021; TfL, 2000–2023.*

As shown in Table 2, total annual bike trips and bike trips per capita in each of the four cities rose similarly to the increases in bike mode share. They confirm that the largest increases were in Paris, but that the highest level of cycling in 2023 was in Berlin (208 bike trips per capita per year). By comparison, Paris had 160 bike trips per capita, London had 44, and NYC had 27. Of particular interest for this study, the additional bike trips per capita during and since COVID were in Paris (92), London (5), and NYC (4). Berlin experienced a slight drop in trips per capita (−6) in spite of its increased number of total bike trips per year (784 to 786 million) and bike mode share (from 18% to 19%). Experts we contacted attributed the slight decline in trips per capita to unusually good weather (for cycling) during Berlin’s 2018 data collection period compared to the more usual weather during the 2023 survey period (Hengstermann, 2025). Another reason might be the increase in Berlin’s population by 230,000 from 2020 to 2023, including refugees from Afghanistan, Syria, and Ukraine, who were less used to cycling than Germans as a means of daily travel.

2.3. Spatial variation in cycling rates within each city

The cycling rates presented in Figure 1 and Table 2 are averages for each of the cities, but there is considerable spatial variation in cycling rates within each city. Of the four cities, spatial variation is greatest in NYC. As shown in Figure 2, the bike mode share of work commuters ranges from about 4–5% in some districts in Manhattan and northwestern Brooklyn to less than 0.5% in most of Staten Island, eastern Brooklyn and Queens, and northeastern Bronx, with bike mode shares of 0.1% or 0.0% in some districts. Thus, the ratio of bike mode share among districts in NYC is at least 10:1. Districts with mode shares of 2% or higher are almost all in Manhattan and western Brooklyn, parts of the city with relatively high incomes, concentrations of young professionals, proximity to employment centers, and recently gentrified neighborhoods. Although not shown on the map, the most extensive and highest-quality cycling facilities

(protected bike lanes) were initially concentrated in Manhattan and northwestern Brooklyn, encouraging even more cycling in those districts. Some groups criticized the concentration of bikeway infrastructure in neighborhoods near the city center as inequitable because lower-income and minority neighborhoods were mostly neglected (Martens et al., 2021; TA & MIT, 2022). Thus, in recent years, NYC’s Department of Transportation has been expanding and improving cycling facilities in other parts of the city (NYCDOT, 2019, 2021, 2025). Similarly, docking stations for NYC’s bikesharing system, Citi Bike, had initially been concentrated in Manhattan and northwestern Brooklyn, but they have also expanded to other parts of the city (all boroughs except Staten Island) to promote greater equity.

While the map for NYC in Figure 2 shows the bike share of work commuters, Figure 3 shows the bicycle percentage of total trips for all purposes for each of London’s 33 ‘Inner’ and ‘Outer’ districts (comprising 32 boroughs plus the City of London). Inner districts and Outer southwest London boroughs tend to have the highest bicycle mode shares, ranging from 4% to 8%. There are exceptions, however, such as the Inner eastern borough of Tower Hamlets (2% mode share). Boroughs with the highest bicycle mode shares include Hackney (Inner northeast, 8%), Hammersmith and Fulham (Inner west, 6%), and Richmond Upon Thames (Outer southwest, 6%). The lowest bicycle mode shares are generally in Outer boroughs located far from the city center, in the northwest, northeast, and southeast. Corresponding to the city-wide bike mode share (4.5% in London compared to NYC’s 3%), the boroughs with the highest rates in London are about a third higher than in the central districts of NYC, while the boroughs with the lowest rates in London are generally not as low as in the outer portions of NYC.

As in NYC, differences among the London districts in cycling infrastructure may help explain variation in cycling mode share. London’s cycling infrastructure was initially designed as commuter-focused, leading from the inner suburbs to the city center. These facilities mostly served cyclists

Table 2. Bicycle trips per year and per capita in New York, London, Paris, and Berlin, 1990–2023.

	1990–1993	1998–2000	2010	2017–2019	2022–2023	Ratio 2023/1990
New York						
Trips per year (million)	35	54	91	194	226	6.5
Trips per Capita	5	7	11	23	27	5.4
London						
Trips per year (million)	98	101	180	369	428	4.4
Trips per Capita	14	14	22	39	44	3.1
Paris						
Trips per year (million)	9	30	88	170	374	41.6
Trips per Capita	4	15	42	77	169	42.4
Berlin						
Trips per year (million)	264	371	473	784	786	3.0
Trips per Capita	77	109	138	214	208	2.7

Note. The actual years vary slightly by city, as follows: New York: 1990, 2000, 2010, 2019, 2022; London: 1993, 2000, 2010, 2019, 2022; Paris: 1990, 2000, 2010, 2017, 2023; Berlin: 1992, 1998, 2010, 2018, 2023.

Sources. City of Paris, 2000–2023; City of Berlin, 2003–2025; IPR, 2015; Kalender, 2012; NYCDOT, 2018–2023; Pucher, Parkin, et al., 2021; TfL, 2000–2023, 2025b.

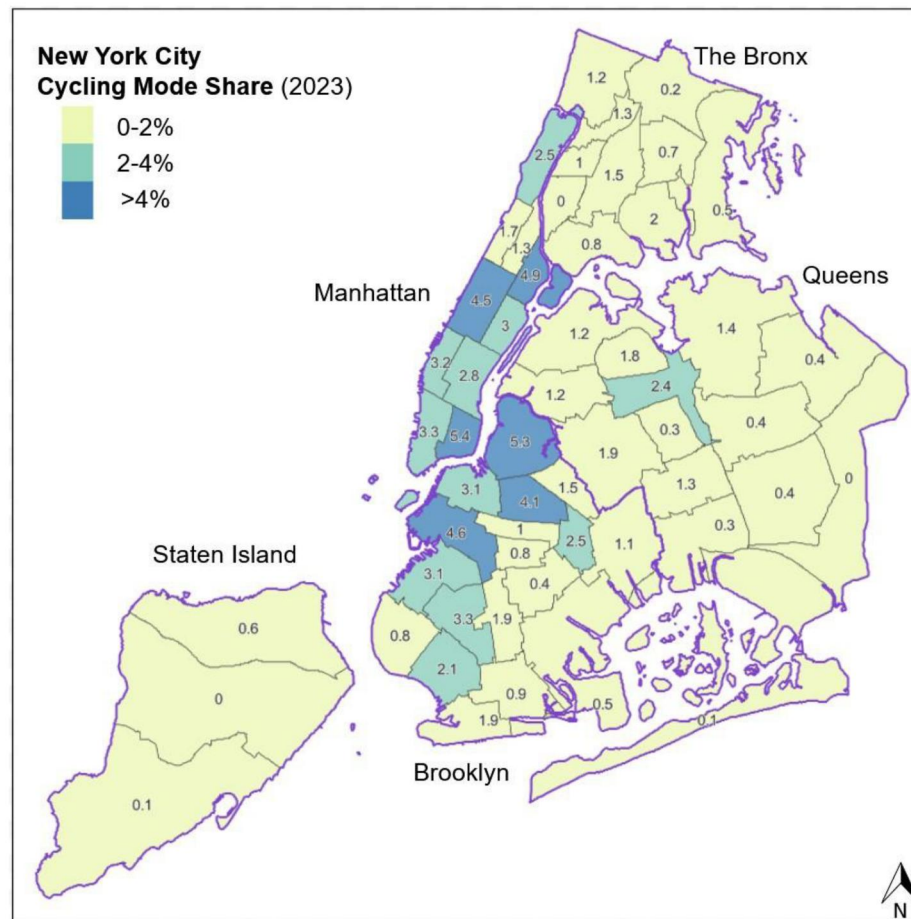


Figure 2. Spatial variation in bike mode share of work commuters in NYC, 2023. Note. Numbers in the map indicate the percentage of total workers in each district commuting by bike to work as their main mode of travel on most days of the week. Source. GIS map created by Marcel Moran based on data for NYC from the 2023 American Community Survey (U.S. Census Bureau, 2024).

traveling to the central business district, likely skewing benefits by income, age, gender, and other demographic factors. As in NYC, the spatial distribution of new infrastructure has changed in recent years. TfL has recently sought to better balance investment between Inner and Outer zones, but spatial inequalities persist and are exacerbated by borough-based planning differences. In both NYC and London, it will be important for future research to determine whether more balanced spatial provision of cycling facilities can help equalize cycling rates among demographic groups.

Somewhat similar to the spatial pattern in NYC and London, rates of cycling in Berlin tend to be highest near the city center and lower toward the periphery. Because the overall mode share of cycling in Berlin (19%) is so much higher than in any of the other three cities, in Figure 4 we use a different color scale indicative of Berlin's ranges of cycling rates. Local transport planners explained in interviews that Berlin's many decentralized commercial subcenters facilitate cycling. Indeed, many daily trips in the city are to and from district centers (Kieze) throughout the city—between homes and daily destinations like supermarkets,

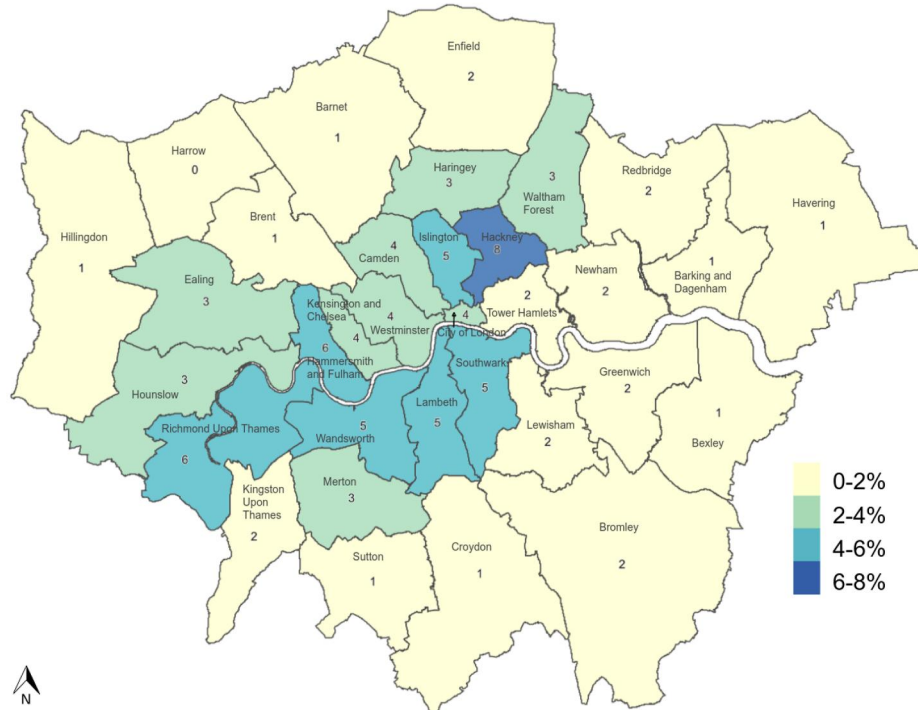
London Cycling Mode Share (2022/23-2023/24 two-year average)

Figure 3. Spatial variation in bike mode share of trips in London, all trip purposes, 2023. Note: Numbers in the map indicate the percentage of total trips by bicycle in each London borough. Source: GIS map created by Marcel Moran based on data averaged from the two fiscal years 2022/2023 and 2023/2024 travel survey for London (TfL, 2000–2023)

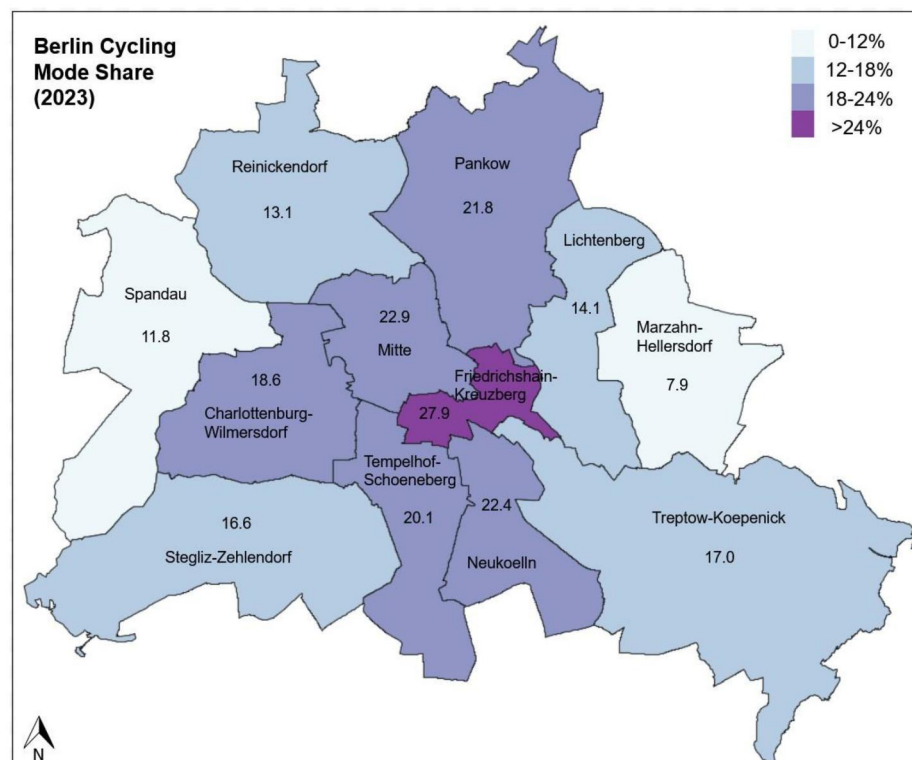


Figure 4. Spatial variation in bike mode share of trips in Berlin, all trip purposes, 2023. Note: Numbers in the map indicate the percentage of total trips by bicycle in each Berlin district (Bezirk). Source: GIS map created by Marcel Moran based on 2023 travel survey (City of Berlin, 2025).

cafes, doctor's offices, shops, and restaurants—resulting in many trips short enough for cycling.

The highest mode share (27.9% in Friedrichshain-Kreuzberg) may be linked not only to its central location

but also its vibrant atmosphere, international cuisines, avant-garde culture, and colorful nightlife, attracting residents more likely to cycle, such as students, artists, and young professionals. Mitte (22.9%) is not far behind,

however, as it is the geographic city center, with many government offices, businesses, stores, universities, and museums. Five districts adjacent to Friedrichshain-Kreuzberg and Mitte have similarly high cycling rates, ranging from 19% to 22%. The local district governments in those seven central districts have also invested the most in high-quality cycling infrastructure. The lowest rates of cycling are in the west (Spandau: 11.8%) and east (Marzahn-Hellersdorf: 7.9%). Those two districts tend to be more car-oriented than other parts of Berlin. Both districts include many single-family houses and have relatively high car ownership rates. Marzahn-Hellersdorf also has some neighborhoods with massive high-rise apartment blocks built by the government of East Berlin and less of a mix of land uses compared to other parts of Berlin. Nevertheless, even those two districts have higher rates of cycling than the districts with the highest rates of cycling in NYC and London.

Unfortunately, we could not obtain disaggregated bike mode shares from the Paris travel survey for the city's 20 arrondissements, and thus could not create a GIS map similar to those for NYC, London, and Berlin. But for the survey year 2023, we were able to obtain bike mode shares for three different geographic jurisdictions: 11% for the City of Paris; 10% for the Petite Couronne—the ring of inner suburbs surrounding Paris; and 4% for the Grand Couronne—the outer suburbs comprising the rest of the Ile de France. The entire Ile de France metropolitan area has a bike mode share of 8%. Although the Grande Couronne contains large areas of rural and agricultural land, its 4% bike mode share is only slightly lower than the overall 4.5% bike mode share for London, and about a third higher than the 3% bike mode share in NYC.

2.4. Variation in cycling rates by trip purpose and socioeconomic characteristics

2.4.1. Distribution of trip purposes

Distributions of trip purposes of cycling are not fully comparable across cities. In some cities, more than one purpose could be reported for a bike trip. Moreover, categories of trip purposes from the cities' most recent travel surveys were not defined identically, although we have tried to aggregate them below in a way to facilitate comparisons. Categories labeled as "other" or "not stated" were zeroed out to calculate our distributions.

In 2022/2023, exercise and recreation accounted for 37% of all bike trips in London, 32% in NYC, 31% in Paris, and 26% in Berlin (City of Berlin, 2025; City of Paris, 2023; NYCDOT, 2023; TfL, 2024). Work trips accounted for 38% of bike trips in London, 35% in Paris, 26% in Berlin, and 16% in NYC. Trips for education (school or university) accounted for 13% of bike trips in Berlin, 11% in Paris, 5% in London, and only 1% in NYC. Shopping and personal business accounted for 38% of bike trips in NYC, 34% in Berlin, 23% in Paris, and 20% in London. If trips for work, education, shopping, and personal business can be considered utilitarian (as opposed to exercise and recreation), they account for the highest percentage in Berlin (73%) compared to 65% in Paris, 63% in London, and 55% in NYC.

2.4.2. Variation by gender

Cycling is dominated by men in NYC (75% of bike trips), London (74%), and Paris (69%). By comparison, there is almost no gender gap in Berlin, with 52% of bike trips by men, and 48% by women. Those city percentages roughly correspond to the percentages of men's shares of bike trips in their countries: 70% in the USA, 71% in the UK, 71% in France, and 51% in Germany. As found by Garrard (2021) and Goel et al. (2022), countries with high overall levels of cycling tend to have smaller (or even reversed) gender gaps than countries with low rates of cycling (e.g. 52% of bike trips by women in Denmark, 54% in the Netherlands, and 55% in Japan). With national cycling rates (for all trip purposes) of 1% in the USA, 1.7% in the UK, and 3% in France, those countries fit the pattern of larger gender gaps than in Germany, which has a national bike share of 11% of all trips (Buehler & Pucher, 2021a; Goel et al., 2022).

2.4.3. Variation by age group

Similar to the differences in trip purpose categories, differences in age categories used by the four city surveys permit only approximate comparisons. Unlike trip purpose, however, variation in cycling rates by age group are best examined by comparing the bike mode share of trips for different age groups. The NYC and Paris surveys excluded people younger than 18 and 16 years, respectively. In London, people aged less than 16 years had a mode share of 1.7%. In sharp contrast, that age group made 22% of their trips by bike in Berlin, the highest bike share of any age group. In NYC, the three age groups 25–34 (3.9%), 35–44 (3.6%), and 45–54 (4.0%) had the highest bike mode shares of all age groups. In London, the age groups 25–44 (6.2%) and 44–64 (5.1%) had the highest bike mode shares, followed by the age group 17–24 (2.9%) and 65+ (2.6%). While in NYC and London, the middle age groups had the highest bike mode share, in Paris, the highest shares were for the age group 16–25 (15%) and 26–45 (16%). Mode share fell considerably for ages 46–65 (10%) and fell even further for 65+ (6%). Bike mode shares in Berlin were higher for all age groups than in NYC, London, and Paris, but they were highest for the youngest age group (22%), next highest for the age groups 25–44 (20%) and 45–64 (19%). The age group 65+ had the lowest mode share (11%) in Berlin, but that was far higher than the highest mode share of any age group in NYC and London and almost twice as high as the 6% bike mode share for the 65+ in Paris.

Overall, these results suggest that Berlin has the youngest average age of the typical cyclist (due to the high mode share for children), followed by Paris (dominance of 16–45 years), and then NYC and London, where middle age groups (25–54) had the most cycling. As discussed in Buehler and Pucher (2021a), Garrard, Conroy, et al. (2021), and Goel et al. (2022), countries and cities with higher bike mode shares have less age inequality in cycling.

2.4.4. Variation by income

Only London and Berlin reported income as part of their travel surveys, and both indicate higher rates of cycling

Table 3. Total annual bike trips, cyclist fatalities, cyclist serious injuries, fatality and injury rates in NYC, London, Paris, and Berlin, 2005–2023.

		2005	2010	2019	2023	% Change 2023 vs 2005 (=100%)
New York City	<i>Bicycle trips (million)</i>	63	91	194	226	259%
	<i>Cyclist fatalities</i>	22	19	25	30	36%
	<i>Cyclist fatality rate (Fatality per 10 million cycling trips)</i>	3.5	2.1	1.3	1.3	−66%
	<i>Cyclist serious injuries</i>	337	362	345	467	39%
	<i>Cyclist serious Injury Rate (Serious injury per 1 million cycling trips)</i>	5.4	3.9	1.8	2.1	−61%
London	<i>Bicycle trips (million)</i>	148	180	369	428	189%
	<i>Cyclist fatalities</i>	16	13	9	8	−50%
	<i>Cyclist fatality rate (Fatality per 10 million cycling trips)</i>	1.1	0.7	0.3	0.2	−84%
	<i>Cyclist serious injuries</i>	657	825	739	976	49%
	<i>Cyclist serious Injury Rate (Serious injury per 1 million cycling trips)</i>	4.4	4.6	2.0	2.3	−48%
Paris	<i>Bicycle trips (million)</i>	45	88	170	383	751%
	<i>Cyclist fatalities</i>	3	4	4	2	−33%
	<i>Cyclist fatality rate (Fatality per 10 million cycling trips)</i>	0.8	0.5	0.2	0.1	−93%
	<i>Cyclist injuries</i>	694	604	688	1079	55%
	<i>Cyclist Injury Rate (Injury per 1 million cycling trips)</i>	15.4	6.9	4.0	2.8	−81%
Berlin	<i>Bicycle trips (million)</i>	422	473	784	786	86%
	<i>Cyclist fatalities</i>	9	10	9	11	18%
	<i>Cyclist fatality rate (Fatality per 10 million cycling trips)</i>	0.2	0.2	0.1	0.1	−37%
	<i>Cyclist serious injuries</i>	490	536	680	612	25%
	<i>Cyclist serious Injury Rate (Serious injury per 1 million cycling trips)</i>	1.2	1.1	0.9	0.8	−33%

Note. Cyclist fatalities for each of the four years were calculated as a 3-year average of fatalities bracketed around the year shown, except for the year 2019, for which we used the 3-year period 2017–2019, to avoid including the first year of COVID (2020) in the three-year running average for 2019. Serious injuries for each year were calculated as a 3-year average of serious injuries bracketed around the year shown, again with the exception of 2019, for which we used the years 2017–2019. Only serious injuries were included for NYC, London, and Berlin, but total injuries (including non-serious injuries) were included for Paris because data on serious injuries were not available. Definitions of serious injuries vary between the cities. Therefore, injury rates are not comparable across cities.

among those with higher incomes. In London, bike mode share was 3.2% for respondents earning less than £20,000 per year, 4.1% for those earning £20,000–£75,000 per year, and 6.3% for those earning more than £75,000 per year. In Berlin, bike mode share was 15% for those with monthly earnings less than €1500 per month (after taxes), 16% for those earning €1500–2599, 15% for those earning €2600–3599, 19% for those earning €3600–€5599, and 24% for those earning €5600 or more. Instead of income, the Paris survey reports the employment profile of cyclists. The bike mode share was 20% for artisans, owners of small businesses, and craftsmen, 19% for professionals with higher education, 15% for professionals with middle education, 7% for manual laborers, 11% for university students, 7% for retirees, and 11% for the unemployed.

2.4.5. Race/ethnicity

NYC and London were the only cities to report cycling levels by race/ethnicity. In NYC (2022), the bike mode share for white respondents was 3.5% compared to 1.5% for Asian and 1.2% for African-American or Black respondents. In London (2023), the bike mode share for white respondents was 6.3%, more than three times as high as for Asian (1.7%) and Black respondents (1.8%). Thus, in both NYC and London, white respondents cycle much more often than other racial groups. A growing literature seeks to understand racial (and other) exclusions within cycling; for instance, Osei and Aldred (2023) highlight how Black cyclists in London face a range of barriers, including public and police harassment.

3. Trends in cycling safety

Cycling safety is a key determinant of cycling rates in cities and countries (Elvik, 2021). Studies consistently find that

increased cycling safety, both objective and subjective, leads to higher cycling rates. The academic literature also finds that some groups are more sensitive to cycling safety than others. Garrard (2021), for example, shows that women tend to be more sensitive than men to potential cycling dangers. Similarly, Garrard, Conroy, et al. (2021) find that older adults are more sensitive to potential cycling dangers than younger adults. Finally, parents are sensitive to cycling safety when determining whether and where to allow their children to ride a bike (McDonald et al., 2021). Thus, improved cycling safety may help reduce demographic inequalities in cycling.

Table 3 reports total cyclist fatalities in NYC, London, Paris, and Berlin in 2005, 2010, 2019, and 2023. It also reports serious cyclist injuries (as defined by each city) in NYC, London, and Berlin but total injuries (including non-serious injuries) for Paris because reliable serious injury data were not available. To offset fluctuations from year to year, 3-year averages were calculated for both fatalities and injuries for each of the four years, bracketed around the year shown in the table. Fatality rates were then calculated per 10 million bike trips, while injury rates were calculated per million bike trips. Absolute totals and rates are shown in the first four columns of the table, one for each of the four years. The percentage change from 2005 to 2023 is shown in the last column of Table 3. The percentages in that column are the focus of the following discussion because differences across cities in definitions, data collection, methodology, and reporting procedures make the comparison of absolute values misleading among cities, especially for serious injuries, where definitions and recording procedures vary substantially. Thus, we focus on the overall trends compared to the year 2005, which we use as the base year (=100 in Table 3 and Figure 5).

As shown in Figure 5, cycling became safer in all four cities over the period 2005 to 2023. The cyclist fatality rate per

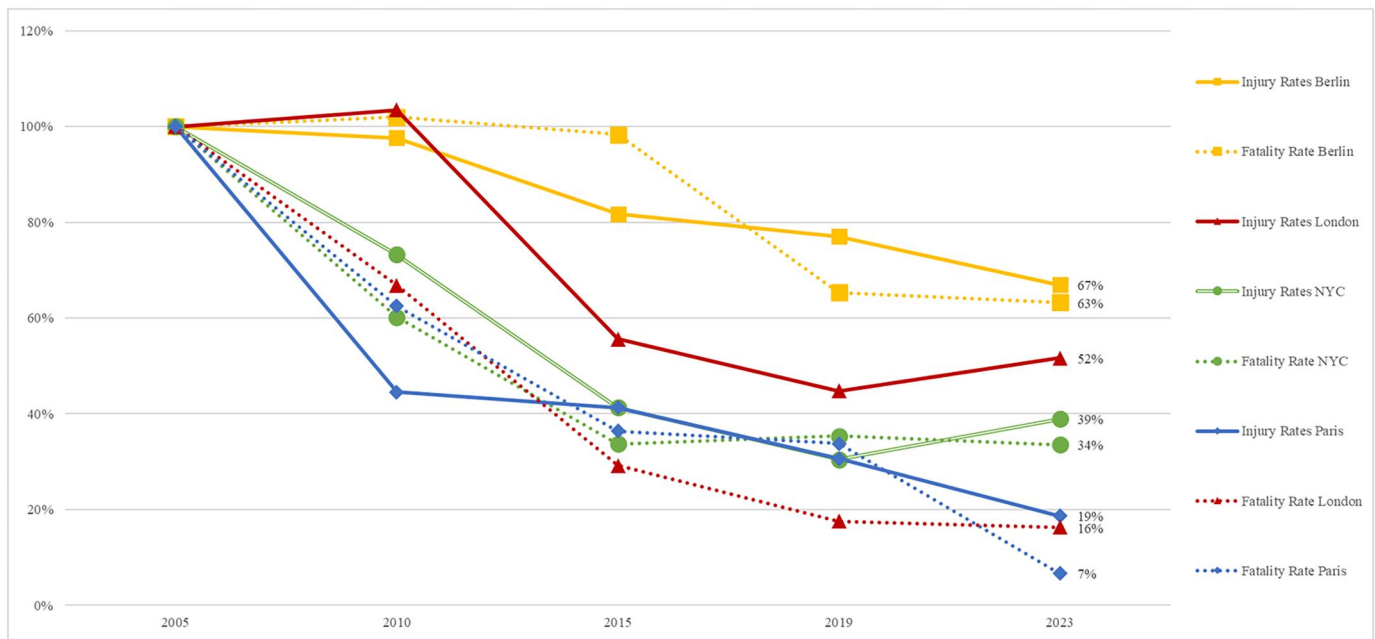


Figure 5. Trends in cyclist fatality and serious injury rates, 2005–2023 (relative to the base year 2005 = 100). *Notes.* The fatality rate is calculated as 3-year average annual fatalities per 10 million bike trips. The serious injury rate is calculated as 3-year average annual serious injuries per million bike trips. See Table 3 for absolute values for each of the four years. Serious injuries are reported for NYC, London, and Berlin, but total injuries (including non-serious injuries) were used in this figure for Paris because data on serious injuries were not available.

10 million bike trips fell by 88% in Paris, 82% in London, 62% in NYC, and 37% in Berlin. The cyclist serious injury rate fell by 62% in NYC, 50% in London, and 37% in Berlin. The all-injury rate in Paris fell by 86%. One deviation from this overall positive trend is that serious injury rates in NYC and London increased slightly between 2019 and 2023. In NYC, that increase was reported by the media and cycling advocacy groups, who attributed rising cyclist injuries to increased speeding (and other traffic violations) by motorists due to lax enforcement of traffic regulations during and since COVID (Collins, 2024; Cuba, 2020; Kuntzman, 2024). Advocacy groups in London have also highlighted this levelling-off and slight reversal of the prior reduction in serious injury rates per trip and have called for improved infrastructure to protect people walking and cycling (LCC, 2024). Although the recent increase in serious injury rates in NYC and London from 2019 to 2023 requires countermeasures, cycling safety over the entire period 2005 to 2023 has greatly improved, as shown in Figure 5.

To improve cyclist and pedestrian safety, London has implemented the Direct Vision Standard for heavy trucks. As in many cities and countries, trucks account for a disproportionately high share of cyclist crashes in London, especially truck turns and the changing of lanes (Pokorný & Pitera, 2019; Pucher, Tiwari, et al., 2021). In 2021, London required trucks over 12 tons that do not meet a minimum standard for driver direct vision to have a camera focused on the curb side of the truck (where cyclist collisions often occur). As of 2024, trucks must also have another camera showing the zone immediately in front of the truck cab (where most pedestrian fatalities occur), and an alert system warning of any imminent collision (TfL, 2025d). Trucks must be certified with a safety permit before they are allowed to operate anywhere in Greater London. TfL reports

that these regulations contributed to a reduction in the number of cyclist and pedestrian fatalities involving trucks (TfL, 2022). These initial results suggest that other cities around the world might also implement a similar regulation for trucks in their cities.

4. Cycling infrastructure

In all four cities, a key focus among transport planners has been the expansion and improvement of cycling facilities, both between and at intersections, to mitigate the dangers motor vehicles pose to cyclists. Initially, that entailed the expanded provision of so-called ‘conventional’ bike lanes, delineated first only by stripes on the roadway and then eventually also by painting of the bike lanes (usually green, but sometimes blue or red) to make cyclists more visible to motorists and to provide cyclists with dedicated space on the road. Some cities supplemented those bike lanes with diagonally striped buffer zones between the bike lane and motor vehicle lanes—designated as buffered bike lanes. Especially after 2010, protected on-street bikeways were increasingly installed, with physical barriers between cyclists and motor vehicles—such as bollards, median islands, raised curbs, planters, and vertical concrete barriers (see Figure 6). The increased physical separation of cyclists from motor vehicles has probably contributed to the increase in cycling safety from 2005 to 2023 (as described in section 3 above).

4.1. New York City

The cycling network in New York City was greatly expanded from 2006 to 2024, and its quality was improved. The city installed 676 km of conventional, striped on-street bike lanes



Figure 6. Protected bike lanes in Berlin, London, Paris, and New York City (from left to right). *Credit: photos by the authors.*

from 2006 to 2019, and 149km more striped bike lanes from 2019 to 2023 (i.e. during and since COVID). The city complemented those dedicated bike lanes with signed/ marked bike routes (with sharrows) on shared streets with light traffic: 425 km from 2006 to 2019, and an additional 49 km from 2019 to 2023.

The most important improvement in NYC's cycling infrastructure came in 2007, when the first protected bike lanes (hereafter, PBLs) were built, physically separated from motor vehicle traffic. Since then, the city's main emphasis has been on expanding its network of PBLs. In the twelve years from 2007 to 2019, the city expanded its PBLs by 223 km (averaging 29 additional km per year), and then by an additional 187 km from 2019 to 2023 (47 additional km per year), with a total of 413 km in 2023. Such protected cycling facilities accounted for 29% of all bike lanes built in 2010, 37% in 2019, and 68% in 2023. Thus, the city has increasingly focused on building PBLs as the core of its cycling network.

4.2. London

The cycling network in Greater London expanded from 2001 to 2024, and its quality greatly improved. Data on cycling infrastructure, however, have been inconsistently recorded, and definitions of the cycling network have changed over time. This stems in part from each borough having considerable control over bike facilities, which has led to significant variance in materials used, design (including bike-lane width and color), as well as accompanying signage. From 2001 until 2017, cycle routes across London were known as the London Cycling Network (LCN+). Delivered mainly by most of the 32 London boroughs, the LCN+ typically comprised painted bike lanes, designated as 'quieter routes' for cyclists (without separate cycling infrastructure), and off-street paths. That LCN+ grew from 435 km in 2001 to 2179 km in 2016, almost a five-fold increase, with most of that expansion occurring between 2002 and 2010 (Buehler & Pucher, 2022).

In 2018 the Mayor's Transport Strategy began referring to the Strategic Cycle Network (SCN), underpinned by two 2017 documents analyzing cycling potential and laying out a strategic analysis. The intention was to move away from the perceived poor quality, patchwork LCN to a more strategic approach to delivering better infrastructure—in particular, more protected bike lanes—where it could have the most

impact. The SCN grew from 90 km of existing routes in 2016 to 403 km in 2024, almost a five-fold increase during that 8-year period. A highlight of the SCN has been London's branded cycleways (numbered C1 to C62 at present), which are prominent routes that connect different boroughs and are usually physically separated from automobile traffic. Although boroughs are responsible for construction along roads they control, the cycleways as a whole are coordinated by Transport for London (TfL) to facilitate inter-borough connections (TfL, 2025a).

The percentage of the Greater London population living within 400 m of the SCN increased from 12% in 2019 (prior to COVID-19) to 19% in December 2021 and 27% in October 2024. TfL aims to further increase that percentage to 40% by 2030 and 70% by 2041 (TfL, 2025a).

4.3. Paris

The cycling network in the City of Paris and its suburbs was greatly expanded from 1996 to 2024, and its quality was improved. From 1996 to 2016, there was a five-fold increase in the cycling network, from 151 km in 1996 to 778 km in 2016 (Pucher, Parkin, et al., 2021). From 2005 to the end of 2020, Paris installed 503 km of bike lanes. Most were protected lanes (332 km, 66%), followed by painted lanes (124 km, 25%), and in 2020, pop-up lanes (47 km, 9%) (Buehler & Pucher, 2022; City of Paris, 2023). Thus, as in NYC, the recent emphasis has been on implementing protected bike lanes (PBLs) separated from motor vehicle traffic.

A key part of Paris's response to the COVID-19 pandemic was the rapid installation of 'pop-up' protected bike lanes, known as 'Coronapistes' (translated as 'Corona lanes'). These lanes, separated from traffic lanes with staggered concrete blocks and plastic posts, were installed in the Spring of 2020, bypassing Paris's standard approach for bike-lane construction in order to expedite their roll-out (Moran, 2022). Of the 47 km of Coronapistes installed in 2020, most have since been converted to permanent protected bike lanes, matching the rest of the city's network in design and materials.

Between 2019 and 2023 (during and since COVID), the total network of cycling facilities grew from 1,245 km to 1,507 km. In 2023, there were 444 km of one-directional PBLs, 411 km of bi-directional PBLs, 137 km of striped bike

lanes, 171 km of shared bus-bike lanes, and 222 km of shared-use paths with pedestrians (City of Paris, 2023). In contrast to London, where bike infrastructure varies significantly by borough, Paris's municipal government has taken a more standardized approach, resulting in more consistency in materials, design, signaling, and signage across arrondissements. As in NYC and London, there are many suggested bike routes in Paris on low-traffic streets, especially in neighborhoods with light motor vehicle traffic and low speed limits. There is a new bike plan in progress (as of 2025) seeking to double the km of bike lanes overall and to build several express bikeways (City of Paris, 2025a). The Summer 2024 Olympics, hosted by Paris, provided additional motivation to expand and improve the cycling network. To facilitate access to Olympic events, the city added 70 km of extra-wide bike lanes (designated as 'Olympistes'), painted pink and marked with the Olympic rings logo (APUR, 2024).

4.4. Berlin

Due to large increases in car ownership, cycling levels in West Berlin plummeted by 92% from 1952 to 1973 (IfV, 2015). Increased car dependence caused serious problems of traffic congestion, traffic safety, pollution, noise, and energy use, diminishing residents' quality of life. In response, West Berlin began implementing measures to curb car use and encourage cycling, walking, and public transport, leading to a 9-fold increase in cycling levels from 1973 to 1990 (IfV, 2015). Between 1971 and 1986, the extent of West Berlin's bikeways nearly doubled: from 271 km to 520 km. Many of those early facilities have been upgraded because they were considered too narrow, poorly designed, and unsafe by today's stricter standards.

In 1991, just after German reunification, Berlin had a total of 695 km of bikeways (564 km in West Berlin and 131 km in East Berlin). In the reunified Berlin, bikeways expanded by 30% during the 1990s, reaching 895 km in 2002 (IfV, 2015). By 2015, bikeways had expanded by another 50%, reaching 1350 km. Broken down by type of facility, between 2002 and 2015, the city built 363 km of separated bike paths, 236 km of striped on-road bike lanes, and 116 km of shared bicycle and pedestrian paths including shared spaces on sidewalks (Buehler & Pucher, 2022).

In 2018, Berlin adopted a new Mobility Law to increase the efficiency and sustainability of the city's transport system. The law prioritizes walking, cycling, and public transport with the goal of increasing traffic safety and equitable accessibility, reducing air pollution, noise, and traffic congestion, fighting climate change, and distributing public space more fairly among transport modes (City of Berlin, 2021).

The Mobility Law and the COVID-19 pandemic spurred more expansion. Between 2020 and 2023, the city built 134 km of new bikeways, including 25 km of protected bike lanes and paths. The city also expanded the number and length of its bicycle priority streets (Fahrradstrassen): from 21.3 km in 2020 to 37.6 km in 2023 (City of Berlin, 2025).

Based on the 2018 Mobility Law, Berlin adopted a new bicycle master plan in 2021 which calls for the creation of a tightly-knit bikeway network by 2030 that is no more than 400 m from 80% of Berlin residents, workplaces, and educational facilities (City of Berlin, 2021). This is similar to London's goal of putting 70% of residents within 400 m of its Strategic Cycle Network (SCN) by 2041. In Berlin, the main network will consist of 870 km of priority routes (up from 494 km in 2019). In streets with fast car traffic (speed limit more than 30 km/h), these priority routes will consist of protected bike lanes wherever possible, and these lanes will be at least 2 m wide (ideally 2.5 m) so that cyclists can pass one another. The main bikeway network will also include 134 km of bicycle expressways, built wider to better accommodate fast cycling (ideally 3 m for cycling paths or lanes and 4 m for bidirectional bicycle infrastructure). Complementary local networks of bikeways (1528 km in length including 2 m to 2.3 m wide cycling paths or lanes along roadways with fast traffic) will connect to the main network, yielding a total of 2371 km of bikeways in Berlin by 2030 (City of Berlin, 2021). As of 2025, implementation of the new bikeway network varies greatly by city district because, as in London, Berlin city districts make the final decisions on bikeway construction.

4.5. Intersection improvements

Improving intersection design is crucial for reducing bike conflicts with motor vehicles (Elvik, 2021; Furth, 2021) because most cyclist fatalities and serious injuries occur at or near intersections. New York, London, Paris, and Berlin have implemented a multifaceted approach to making intersection crossings safer for cyclists, usually including some of the following: advance stop lines (3–5 m ahead of the stop line for cars); separate turning lanes for cyclists; mixing zones; offset crossings; painted intersection islands; special bike crossing markings within the intersection; and special bike traffic signals that give cyclists an advance green light, a special signal phase where motorists are prohibited from making turns crossing the bike lane (City of Berlin, 2021; Furth, 2021; NYCDOT, 2019; Pucher, Parkin, et al., 2021). Intersections with these sorts of safety features are sometimes designated as protected intersections (Furth, 2021). Streets with PBLs often feature protected intersections; thus, protected intersections have expanded along with the network of PBLs (see Figure 7).

4.6. Bike parking

Parking facilities are a critical component of overall cycling infrastructure (Buehler et al., 2021c; Heinen & Buehler, 2019). All four cities have been increasing bike-parking supply over the past 25 years, but statistics are not comparable across cities because they rarely capture differences in the quality and type of bike parking. Furthermore, statistics for some cities are rough estimates by city officials as opposed to exact inventories of bike parking spaces. In this section, we provide information gleaned from publicly accessible city



Figure 7. Intersections designed to increase cyclist visibility and safety in Berlin, New York, and Paris (from left to right). *Credit: photos by the authors.*



Figure 8. Bike parking in Paris, London, New York City, and Berlin (from left to right). *Credit: photos by the authors.*

websites and from correspondence with transport planners, city officials, and cycling advocates in each city.

Although bike parking statistics are incomparable among cities, the available data suggest considerable increases for each city before, during, and since COVID. For example, NYC increased bike parking spaces from 10,000 in 2006 to 60,000 in 2019, and 87,000 in 2023. Paris increased its supply of bike parking spaces from 36,400 in 2010 to 51,372 in 2019 and 91,514 in 2022 (Buehler & Pucher, 2022; City of Paris, 2025a; Pucher, Parkin, et al., 2021). Bike parking in Berlin increased from 10,000 in 2009 to 18,600 spaces in 2018, and to 45,000 spaces in 2023 (City of Berlin, 2025; IfV, 2015). While there are no trend data available for London, the city had over 150,000 bike parking spaces in 2025 (TfL, 2025e).

Even though the number of bike parking spaces increased, the quality of bicycle parking often remains poor, especially in NYC (NYCDOT, 2025). Indeed, in all four cities, most bike parking is unsheltered and not secured from theft and vandalism. To increase bike parking quality, in 2024 Berlin opened a new underground bike parking garage in the city center for 200 bicycles, including bicycle lockers and a bicycle repair station. London has introduced bike parking ‘hangars’ (5600 as of June, 2025), which take up the space of a single car parking spot and can fit six bicycles or fewer cargo bikes (see second photo from the left in Figure 8) (Clean Streets, 2024; TfL, 2025e). Paris is steadily expanding and improving bike parking, including secure bike lockers in the street and larger spaces designated specifically for cargo bikes. NYC currently has built only a few partially-covered, unsecured bike shelters, but has recently begun partnerships with private vendors to supply sheltered and secured bike parking (NYCDOT, 2025).

Except for NYC, special efforts are being made to improve bike-transit integration. For example, the public transport operators in the Ile de France region (RATP and SNCF) are planning a vast expansion of secure bike parking facilities at metro,

suburban rail, and long-distance rail stations. Almost all underground and suburban rail stations in London had bike parking, with over 20,000 spaces in 2024 (Clean Streets, 2024; TfL, 2025e). In 2023, Berlin had 39,000 bike parking spaces at public transport stops and stations (City of Berlin, 2025). Moreover, the new bike parking garage in Berlin serves numerous public transport lines.

4.7. Bikesharing

All four cities have both docked as well as dockless bikesharing systems that allow users to rent bicycles for short intra-city trips. They usually offer annual or monthly memberships that keep per-trip costs low, although they generally allow for single-trip rentals as well. Bikes in docked systems are parked in permanent bike docking stations, whereas bikes in dockless systems are generally parked in regular bike racks, bike corrals, or on sidewalks. Docked bikesharing is much more important in NYC and Paris than in London and Berlin. In 2024, for example, total ridership was 49 million trips in Paris and 45 million in NYC, compared to only 10 million in London and only 4 million in Berlin (Citi Bike, 2025; Nextbike, 2025; TfL, 2025c; Vélib’, 2025; Ville de Paris, 2024). On a per-capita basis, annual ridership was 7.4 trips in Paris, 5.2 in NYC, 1.1 in London, and 1.0 in Berlin. Those per-capita trip numbers reflect the populations of the cities themselves as well suburban service areas in the cases of Paris and NYC. Although all four cities also have dockless bikesharing systems, they do not make their ridership numbers publicly available.

Especially in Paris and New York City, the number of docking stations and bikes has greatly increased over the past decade, thus increasing the geographic reach and convenience of bikesharing. Over the last five years, all four cities have increased the share of e-bikes in their fleet of

bikesharing bikes, reaching one-third in NYC and 40% in Paris in 2024. In all cities, e-bikes are used at a higher rate than regular bikes. For example, Citi Bike's fleet in NYC is one-third electric, but in 2024, two-thirds of all Citi Bike trips were taken on e-bikes (Knoth, 2025).

5. Reducing traffic speeds and volumes in residential neighborhoods

Many residential neighborhoods in London, Paris, and Berlin have reduced traffic volumes and speeds using a variety of infrastructure modifications, speed limits, and restrictions on motor vehicle traffic passing through neighborhoods. In London, Low-Traffic Neighborhoods (LTNs) go beyond traditional traffic calming by substantially reducing (not just slowing) motor vehicle traffic. Initially introduced in 2015/2016 as part of the Outer London 'mini-Hollands' program, they were then rebranded as LTNs and introduced more widely. Between 2020 and 2024, 103 LTNs were implemented across Greater London, with 26 later removed (Furlong et al., 2025). Most remaining LTNs are located in Inner London, where the default speed limit is 20 mph in residential areas. LTNs use a combination of bollards, wooden planters, turn restrictions, modal filters (excluding cars and trucks), enforcement cameras, road narrowing and sidewalk widening to prevent drivers from cutting through residential areas and to reduce the speed of the remaining motor vehicle traffic. People walking, wheeling, and cycling are permitted through LTN road closures, which often feature exemptions for disabled car users with 'Blue Badges'.

'School Streets' is another traffic reduction measure that has been implemented in London, Paris, and to a lesser extent, New York. While the specific means of implementation vary by borough, all London 'School Streets' restrict motor vehicle access (not only through traffic, as with LTNs) to one or two streets or sections of streets closest to a school—but only during school opening and closing hours on weekdays during the school term. They were initially introduced in 2015 but were expanded considerably during the COVID pandemic, financed with special COVID funding (Thomas et al., 2022). As of 2025, there are more than 500 'School Streets' in place, and more are being installed and planned.

The City of Paris has implemented several programs to reduce speed limits and motorized traffic volumes. In August 2021, the city reduced the general speed limit to 30 km/h on all streets except some major roadways. Between 2020 and 2024, Paris implemented 85 'Rue Végétales' (Garden Streets), car-free streets enhanced by greenery (City of Paris, 2025b). As of May 2025, 29 additional 'Rues Végétales' were under construction, with more planned as the result of a March 2025 referendum that approved this expansion. As of summer 2025, Paris had over 250 car-free 'Rues aux Écoles' ('School Streets') (Moran, 2026). At first, 'Rues aux Écoles' are closed to vehicular traffic using a simple gate, followed later by more-extensive landscaping, temperature-cooling pavement, and the addition of street furniture, including bike-parking corrals. In November 2024,

the four central city districts (Arrondissements 1–4) banned motorized through traffic—with exceptions for deliveries and motorists with disabilities (City of Paris, 2025b).

Paris has been increasing the number of car-free zones, designated as "Coeur Piétons," where only pedestrians, bicycles, and public transport vehicles are allowed. As of 2024, it encompassed 5.5km² in arrondissements 1 through 4, which are in central Paris (EuroNews, 2024). Paris also plans to remove 60,000 car parking spaces by 2030 and to replace them with green areas, including trees and shrubbery, thus making car use even more difficult.

As with bikeways, Berlin has the longest history of traffic calming among our case study cities. West Berlin traffic calmed its first residential streets in the 1980s. The percentage of all roads traffic-calmed to 30 km/h or less rose from 72% in 2004 to 80% in 2024, including 365 Spielstrassen (neighborhood "play streets"), roadway segments with even lower speed limits of 7-10km/h, which require motorists to yield to pedestrians, cyclists, and playing children. Although not as extensive as in other German cities, there are 16 car-free pedestrian zones in Berlin. More recently, Berlin has introduced two shared spaces, where pedestrians, cyclists, and motorized traffic jointly share the roadway with a requirement to not endanger other roadway users and a maximum speed limit of 20 km/h (if conditions permit).

Of the four cities, NYC has done least to traffic-calm its residential neighborhoods. From 2015 to 2018, NYC experimented with Neighborhood Slow Zones (NSZs) with reduced speed limits of 20 mph (32 km/h). As of 2025, there were 26 such NSZs spread across all five boroughs. They feature minimal infrastructure modifications (such as speed humps) to force drivers to slow down and to discourage traffic passing through neighborhoods (NYCDOT, 2025). New York City also has 71 school streets, which are temporarily closed to motor vehicles to increase student safety during drop-off and pick-up times. Instead of traffic calming individual neighborhoods, NYC's approach was to reduce the general speed limit in 2013 from 30 mph (48 km/h) to 25 mph (40 km/h) on all roads except highways. To enforce that 25 mph speed limit, NYC maintains the largest speed-camera program in the United States, with over 2,000 cameras as of 2024 (Moran, 2024). The city automatically issues fines for vehicles photographed exceeding the speed limit.

New York City and London have implemented congestion charging in their central cities to reduce motor vehicle travel volumes. Congestion charging has been in effect in central London since 2003, with a £15 daily fee for cars from 7:00 am to 6:00 pm on weekdays and from noon to 6 pm on Saturdays, Sundays, and bank holidays. New York City introduced congestion pricing in January 2025 in Manhattan, south of 60th Street, with a charge of \$9 for cars entering that part of Manhattan between 5am and 9pm on weekdays and 9am and 9pm on weekends, and with higher fees for larger motor vehicles such as trucks. In both cities motor vehicle traffic volumes have declined, and revenues have been used to improve public transport systems. Although the reduced motor vehicle traffic resulting from congestion charging might have encouraged more cycling,

there is no firm evidence of this effect, especially because of the difficulty of controlling for the impact of expanded and improved cycling facilities over the same period.

6. Political support, funding, and technical implementation of pro-bike policies

In all four cities, expanded and improved cycling infrastructure and complementary policies to limit car use required strong and long-term political and public support, government funding, and technical planning and engineering staff.

6.1. Political leadership

In Paris, Mayors Bertrand Delanoë (2001–2014) and Anne Hidalgo (since 2014) have provided strong leadership in the transformation of Paris. Both mayors have supported expanded and improved cycling infrastructure as well as a range of restraints on car use such as the traffic-calming of residential neighborhoods and commercial centers, establishment of zones without motor vehicle traffic, reduced speed limits, and reduced car parking supply combined with increased parking fees (Bennett, 2021; Sisson, 2020).

Similarly, improved cycling infrastructure and complementary car-restraint policies in Greater London had the support of Mayors Ken Livingston (2000–2008), Boris Johnson (2008–2016), and Sadiq Khan (since 2016). In New York, the big push for improved cycling infrastructure and complementary policies came during the 11-year tenure of Mayor Michael Bloomberg (2002–2013), primarily due to his support for the Commissioner of Transportation Janette Sadik-Khan (2007–2013). Their pro-bike policies were continued under subsequent mayors Bill de Blasio (2014–2021) and to a lesser extent, Eric Adams (2021–2025).

In contrast, Berlin's push for expanded and improved cycling facilities has been in response to grassroots demands from the public, with less top-down leadership from mayors than in the other three cities. That is partly due to the legislative form of Berlin's government, where the mayor's power is more limited than in the other three cities. For example, the most recent initiative to promote cycling was Berlin's 2018 Mobility Law passed in response to the threat of a binding public referendum demanding more sustainable transport (Werschmöller et al., 2024). Although Berlin has made some progress implementing the cycling section of the Mobility Law, the new conservative-led (CDU) city government (since 2023), has been underfunding bicycle projects in favor of car-friendly policies.

6.2. Funding

Government funding is obviously necessary to finance expanded and improved cycling infrastructure as well as car-restraint measures that require roadway modifications, such as traffic calming. Although some funding data are available for individual cities and specific time periods, they are generally incomplete and not comparable across cities or over time. Nevertheless, the available data indicate large increases in government funding for cycling in all four cities, mostly with local government funds

but often supplemented by national and provincial/state government funds specifically dedicated to urban transport. For example, funding for cycling in London rose from only £9 million in 2002 to £150 million in 2025 (in inflation-adjusted 2024 £). Berlin increased funding for cycling from €2 million in 2000 to €31 million in 2023 (in inflation-adjusted 2024 €) (City of Berlin, 2025; Pucher & Buehler, 2007).

6.3. Advocacy organizations supporting cycling

London, New York, Paris, and Berlin have strong cycling advocacy organizations that support laws and funding to improve cycling conditions, offer bike training, and coordinate group rides and special events (Pucher et al., 2021c). The main cycling advocacy groups are the London Cycling Campaign (LCC) in London; Transportation Alternatives (TA) and Bike New York (BNY) in New York; Mieux se déplacer à Bicyclette (MDB) and Paris en Selle (PS) in Paris; and the Berlin chapter of the Allgemeiner Deutscher Fahrrad-Club (ADFC). For decades, these advocacy groups have lobbied for safe and separate bikeway infrastructure, lower motor vehicle speed limits in general, and neighborhood traffic calming, in particular. They also organize and/or support highly visible cycling events such as RideLondon FreeCycle in London; Century Bike Tour and Five-Borough Bike Ride in New York; and the Sternfahrt in Berlin. They also organize numerous bike training courses, cycling repair workshops, and provide input to ongoing transport and city planning. Finally, they have advocated for stricter enforcement of traffic laws and regulations intended to protect cyclists from motor vehicle traffic.

7. Conclusions

Paris, London, New York, and Berlin increased their cycling rates (both per capita and as mode share) over the entire period examined in this paper: from 1990 to 2023, including the period during and since peak COVID (2020 to 2023). Cycling injury and fatality rates (relative to total bike trips) fell sharply from 2005 to 2019. Cycling safety continued to improve during and since COVID in Paris and Berlin but stagnated in New York and London, with slight increases in injury rates. Although the timing and specific measures toward more and safer cycling have differed among the four cities, there are some commonalities. In all four cities, the cornerstone has been the expansion and improvement of cycling infrastructure, especially a focus on cycleways separated from motor vehicle traffic. As experience in these cities shows, it is crucial that cycling infrastructure be integrated into a continuous network. The COVID pandemic accelerated the construction of bikeways in all four cities due to increased funding and the need for an alternative to public transport. In many instances, that enabled new bike connections that closed some of the gaps in the bike network.

The public health emergency of the COVID pandemic led to the introduction of several innovative measures in cities throughout the world that proved to be so successful

that they were made permanent and continued after COVID (Latanville & Mitra, 2025; Oluyede et al., 2024). That is also true for our four cities (Buehler & Pucher, 2022, 2024). For example, ‘pop-up’ (provisional) bike lanes were installed in all four of the cities included in our study. In Paris, almost all of those pop-up bike lanes were converted into permanent, protected bike lanes, with physical barriers separating them from motor vehicle traffic. Moreover, the conversion of most lanes of Rue de Rivoli in central Paris during COVID for exclusive use of bicycles (and e-scooters) has been maintained in the years since COVID. Similarly, the vast expansion of traffic-calmed neighborhoods, school streets, car-free zones, and reduced speed limits in Paris and London during COVID has continued in the years since COVID.

In all four cities, however, cycling transformations remain incomplete, with spatial and social inequalities in cycling rates persisting. Most of the existing literature on cycling inequalities has focused on gender (Garrard, 2021), but inequalities by age, ability, race, ethnicity, and income have been increasingly studied (Dadashova et al., 2023; Golob et al., 2016; Martens et al., 2021). It will be important to study the impacts on socio-economic differences in cycling rates of current attempts in the four cities to equalize the distribution of cycling infrastructure.

Bike parking in all four cities has expanded and improved, but it is still not sufficient to meet cyclists’ needs—in particular, there is demand for more secure and sheltered bike parking at public transport stations. Although docked bikesharing has been available in all four cities for over a decade, it has been much more important in NYC and Paris (over 5 trips per inhabitant in 2024) than in Berlin and London (only 1 trip per inhabitant).

Traffic calming of residential neighborhoods has been a key measure to reduce the volumes and speeds of motor vehicle traffic, thus making cycling less dangerous and more pleasant. Such traffic-calmed streets provide crucial connections for cyclists between neighborhood streets and major roadways with protected cycleways. In 2024, for example, 80% of Berlin’s roadway network was traffic calmed to 30 km/h or less. Paris and London have increasingly traffic-calmed their inner districts and residential neighborhoods in recent years, as described in Section 6 of this paper. By 2025, there were almost 300 Garden Streets and School Streets in Paris and almost 600 Low-Traffic Neighborhoods and School Streets in London. Paris, London, and Berlin also have extensive car-free pedestrian zones where cycling is usually allowed. There is a need to assess whether expansion of traffic-calming to more neighborhoods will increase cycling rates of children and older adults, who are most likely to cycle in their own neighborhoods (Garrard, Conroy, et al., 2021; McDonald et al., 2021).

Due to strong political and public resistance to traffic calming measures in NYC, as in most American cities, there were only 26 traffic-calmed neighborhoods in 2025, with speed limits of 20 mph (32 km/h). The main approach in NYC has been to reduce its general speed limit to 25 mph (40 km/h) on all roads except highways, enforced by over

2,000 speed cameras that automatically detect and ticket violators—the most, by far, of any city in the USA. All four cities have increased car parking fees and reduced parking supply, especially in central districts. Both London and NYC have congestion charging, which imposes a special daily fee (£15 in London; \$9 in NYC) to enter their city centers.

One key lesson from the four cities is that pro-cycling measures such as improved cycling infrastructure must be accompanied by car-restrictive measures that make driving more expensive, slower, and less convenient, especially compared to cycling. Pro-cycling measures alone will not be nearly as effective as when combined with car restrictions. As noted previously, the emergency nature of the COVID pandemic generated public and political support that enabled the introduction of vastly expanded car-restrictive measures in each of our four cities.

For both pro-cycling and car-restrictive policies, continued political and public support is key to implementation. For over two decades (indeed four decades in Berlin), city governments have supported vastly expanded and improved cycling infrastructure, and more recently have implemented a range of car-restrictive measures, which, as noted above, have been less extensive in NYC than in the other three cities. There is always the risk that future mayors in all four cities will not provide the necessary funding for bikeway expansions and might also oppose additional measures to discourage car use or even rescind car-restrictive measures imposed by their predecessors. That has already happened in Berlin, where the new conservative government has announced plans to increase the speed limits on 23 currently traffic-calmed streets from 30 km/h to 50 km/h. At the same time, the new government has also cut back funding for bikeway expansion. In NYC, a looming danger is that the federal government will sharply restrict funding for cycling projects. Indeed, the new Secretary of Transportation Sean Duffy of the Trump Administration has specifically targeted cycling for drastic funding cuts. Because federal funds account for 80% of total funding for cycling projects in the USA, it would be difficult for NYC to offset that loss. The other three cities are not as dependent on national funding, but as seen in Berlin, cutbacks in local funding can also slow down or stop the expansion of cycling facilities. Similarly, cutbacks on cycling funding and car-restrictive measures in the model cycling cities of Portland, Oregon and Seville, Spain led to significant reductions in cycling levels when car-supportive mayors succeeded pro-cycling mayors (Geller & Marques, 2021).

Further expansion and improvement of cycling facilities will require continued funding and commitment by local, state, and national governments. That requires long-term political and public support. Increasing public awareness of the wide range of benefits of cycling would help generate the necessary support, both among the public and among politicians who must be convinced to devote more public funding to cycling. As we document in our four cities, public and political support are essential for increasing cycling and making it safer.

There are many reasons for local, state and national governments to encourage more and safer cycling in cities (Buehler & Pucher, 2021b). Cycling causes virtually no noise or air pollution and consumes far less nonrenewable resources than any motorized transport mode (Handy, 2023; Heinen & Gotschi, 2022; Newman & Kenworthy, 2015). Except for E-bikes, the only energy cycling requires is provided directly by the cyclist, and the very use of that energy offers valuable cardiovascular exercise (Celis-Morales et al., 2017). Cycling requires only a small fraction of the space needed for the use and parking of cars. Moreover, cycling is economical, costing far less than the private car, both in direct user costs and public infrastructure costs (Handy, 2023; Newman & Kenworthy, 2015). Because it is affordable by virtually everyone, cycling has the potential to be an especially equitable transport mode (Banister, 2018). In short, cycling has the potential to contribute significantly to environmental, social and economic sustainability. Consequently, both the European Union (EU) and the US Department of Transportation (during the Biden Administration) officially recognized the importance of cycling as a practical mode of urban transport and endorsed the dual objectives of raising cycling levels while increasing cycling safety (EU, 2024; USDOT, 2022, 2025a, 2025b).

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