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ORIGINAL PAPER

# Micromobility Vehicles, Obstructions, and Rider Safety Behaviors in New York City Bike Lanes

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## Abstract

Micromobility vehicles (MMVs) have become increasingly popular, particularly in urban areas where infrastructure has improved in recent years to facilitate their use. The purpose of this study was to observe protected bike lanes in 10 zones of Manhattan, NYC to: (1) describe the MMVs in bike lanes by type, phone and helmet use; and (2) document MMV users' responses to obstructions. Approximately 1 in 4 of all riders (260/998) were wearing a helmet. Fewer than 2% were observed using a phone while moving. Fewer than 9% of Citi Bike users were wearing a helmet. In contrast, over one-third of non-Citi Bike users were wearing a helmet (228 of 670, 34.03%). This difference was determined to be significant by a chi-squared test (a = 0.05) with a p-value less than 0.0001. Of the 988 MMVs observed in this study, 398 (40.28%) were motorized and 590 (59.72%) were non-motorized. A similar proportion of users of motorized riders versus non-motorized vehicles were wearing a helmet (28.14%, 112/398 versus 24.41%, 144/590). A total of 232 riders (23.50%) encountered an obstruction in their bike lane. Of these obstructions in a bike lane, 82.33% (191/232) were a car/vehicle and 17.67% (41/232) was garbage. A large majority of riders (87.93%) reacted by riding into the traffic lane. These findings suggest that further research and local education, enforcement, and legislative efforts are needed to examine and implement best practices in the safe operation of MMVs, decreasing bike lane obstructions, promoting helmet use, and raising awareness of MMV legislation.

**Keywords** Micromobility Vehicles · Bicycle Safety · Bicycle Lane Obstructions · New York City · E-Bikes · Helmet Use

## Introduction

Use of micromobility vehicles (MMVs) has increased significantly across the United States, particularly in urban environments where infrastructure has improved in recent years to promote and accommodate riders [1]. The definition of MMVs has evolved to include a widening range of individual and shared transportation devices. As defined by the Federal Highway Administration, micromobility encompasses "any small, low-speed, human- or electric-powered transportation device" [1]. These devices include bicycles, electric-assisted bikes (e-bikes), scooters, e-scooters, and other lightweight, wheeled conveyances including e-hoverboard, e-skateboard, e-unicyle, and Segway.® Motorized devices are designed to travel at a low speed mostly at or below 20 miles per hour (MPH), although some can reach a top speed of 30 MPH [2].

By implementing shared micromobility systems that include bike, dockless e-scooter, and e-bike share programs,

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cities and towns across the U.S. are providing more accessible means of transportation, with a growing emphasis on equitable distribution of these programs [1, 3, 4]. Additional benefits of using such programs include reduced congestion as well as various user-health [5–7] and environmental benefits [8–10]. As MMV use becomes more widespread and increases transportation accessibility [1], initiatives that promote safety and equity are important, especially in areas of high population density [1]. This proves to be challenging as MMVs often share infrastructure with pedestrians and cyclists, potentially creating safety issues and tension over shared space [11].

New Yorkers are frequent users of bicycles, and as of 2021 the city has responded with 1,456 lane miles of bike lanes and 590 protected bike lane miles [12]. Protected bike lanes are generally separated from motorized vehicle traffic by physical barriers [13]. Research indicates that investments in bike lanes in New York City (NYC) are cost-effective and result in increased use [12, 14]. Daily bicycle use grew 104% between 2011 and 2021, with an estimated 30% of NYC residents riding a bike and nearly 900,000 doing so daily [12]. Accounting in part for the rise in NYC biking is the institution of Citi Bike, the bike sharing system implemented in NYC in 2013. Data suggests that Citi Bikes were popular at the outset with over a million trips taken in October 2013 alone [15]. Citi Bike use remained resilient after the COVID-19 pandemic, while public transit faltered [16], thus suggesting long-term viability of NYC's bike sharing program. Adding to traffic, e-bike and e-scooter use in NYC bike lanes and streets began legally in November, 2020, for those 16 or older [17]. Mopeds (class A, B, C) are not legally permitted in bike lanes, while e-skateboards, Segways,® e-hoverboard, and e-unicyles are considered illegal in NYC [18].

The rise in urban cycling and MMV use has been accompanied by an increase in related morbidity and mortality. According to 2021 bicycle crash data, there were 4,949 bicyclist injuries and 19 deaths in NYC as well as 2,138 injuries and 15 deaths on "other motorized vehicles [19]." Between 1996 and 2005, there were 225 bicyclist fatalities in NYC [20]. Prior research indicates that nearly one-third of injured bicyclists were working at the time of injury (e.g., food or other delivery services) [21]. Researchers found correlations between the number of clavicle fractures and the number of daily cycling trips, use of bicycles as transportation to work, mileage of bicycle lane, and public bicycle-sharing in NYC [22]. In a comparison of e-scooter and bicycle emergency room injury data, findings indicate that head injuries are comparable, but concussions with loss of consciousness are more common among e-scooter riders [23].

Prior studies of NYC bicyclists indicate that helmet use is low. A study of helmet use in 4,919 public bike share riders in NYC indicated only 545 (11.1%) were wearing helmets [24]. Further, an analysis of distracted biking demonstrated that, compared with riders on personal bikes, public bike share riders in NYC were more likely to be engaged in distracted behavior and less likely to wear a helmet [25]. A 2018 study found that protected bike lanes in NYC had obstructions ranging from objects to parked vehicles [26]. Others have questioned the design of protected bike lanes [27].

Efforts between civilian reporting and the Department of Transportation are underway to combat vehicle parking in bike lanes [28]. Insufficient research is available on how bicyclists and other MMV riders react when encountering bike lane obstructions. Further, despite the rise in popularity of MMVs, almost all research about behavior in bike lanes in NYC to date is focused only on bicycles. The purpose of this study was to observe bike lanes in 10 zones of Manhattan, NYC to: (1) describe the MMVs in bike lanes by type, coding phone and helmet use; and (2) document MMV users' responses to obstructions.

## Methods

This was a cross-sectional observational study with two components. First, the way in which operators of micromobility vehicles responded to obstructions in the bicycle lanes in 10 zones of Manhattan, NYC was noted. Second, type of MMVs used, helmet and mobile phone use were coded.

The geographic boundaries of the zones were derived from our prior observational studies in Manhattan, NYC [26]: Zone 1 Uptown East—above 96th Street; Zone 2 Uptown West—above 96th Street; Zone 3 Midtown East—between 34th Street and 59th Street; Zone 4 Midtown West—between 34th Street and 59th Street; Zone 5 Between Midtown and Downtown East between 34th Street and 14th Street; Zone 6 Between Midtown and Downtown West 34th Street and 14th Street; Zone 7 Downtown West Below 14th Street; Zone 8 Downtown East Below 14th Street; Zone 9 Between Midtown and Uptown West between 59th Street and 96th Street; Zone 10 Between Midtown and Uptown East between 59th Street and 96th Street.

Bike lanes vary throughout the city and for the purpose of this study, only protected bike lanes were included. As with our previous work, limiting the study to bike lanes was based on the notion that a rider would expect a higher level of security as the lane is not shared with cars and other vehicles. Our prior research [26] and the current NYC bike map [29] were used to determine and verify zones and protected lanes.

The first aspect of the study included enumeration of MMV type as well as coding for several rider characteristics.

**Table 1** Types of Micromobility Vehicles (N = 988)

| TYPE OF MICROMOBILITY VEHICLE | Count | Percent |
|---|---|---|
| **Citi Bike electric** | 17 | 1.72% |
| **Citi Bike regular** | 301 | 30.47% |
| **Electric bike** | 315 | 31.88% |
| **Regular bike** | 289 | 29.25% |
| **Moped** | 16 | 1.62% |
| **Stand up electric scooter** | 26 | 2.63% |
| **Electric skateboard** | 3 | 0.30% |
| **Motorcycle/dirt bike** | 21 | 2.13% |

Specifically, type of MMV (electric bike, non-electric bike, electric scooter, electric skateboard, and motorcycle/dirt bike), phone use, and helmet use were documented. The second component of the study involved coding obstructions in protected bike lanes. Objects in the protected bike lane were considered obstructions if they were substantial enough that a rider could not ride straight over them. In this study, all obstructions fit into one of two categories: a car/vehicle in the bike lane or presence of garbage in the bike lane. The researcher stood near one obstruction in each zone for a total of 15 min and noted the manner in which oncoming MMV operators reacted to the obstruction. Descriptive statistics were calculated using Microsoft Excel. This study was approved by the Institutional Review Boards at William Paterson University and Teachers College, Columbia University.

## Results

A total of 988 riders were observed in 10 different zones. The number of riders observed in each zone varies: 1, 99 (10.02%); 2, 98 (9.92%); 3, 99 (10.02%); 4, 100 (10.12%); 5, 103 (10.43%); 6, 98 (9.92%); 7, 96 (9.72%); 8, 96 (9.72%); 9, 99 (10.02%); and 10, 100 (10.12%). Selected characteristics recorded for each of the 988 micromobility vehicles observed is shown in Table 1. The majority of MMVs were regular Citi Bikes (n = 301) or regular bicycles (n = 289). Approximately 1 in 4 of all riders (260/998) were wearing a helmet. Fewer than 2% were observed using a phone while moving.

Fewer than 9% (n = 28 of 318, out of 17 on e-bikes and 301 on regular bikes) of Citi Bike users were wearing a helmet. In contrast, over one-third of non-Citi Bike users were wearing a helmet (228 of 670, 34.03%). This difference was determined to be significant by a chi-squared test (a = 0.05) with a p-value less than 0.0001. Of the 988 MMVs observed in this study, 398 (40.28%) were motorized and 590 (59.72%) were non-motorized. A similar proportion of users of motorized riders versus non-motorized vehicles were wearing a helmet (28.14%, 112/398 versus 24.41%, 144/590). A chi-squared test (a = 0.05) determined that this difference was not statistically significant with p = .1889.

**Table 2** Reactions from Micromobility Operators to an Obstruction in Bike Lane (N = 232)

| Reaction | Count | Percent |
|---|---|---|
| Ride Into Traffic Lane | 204 | 87.93% |
| Stop and Wait | 1 | 0.43% |
| Ride Onto Sidewalk | 7 | 3.02% |
| Stay In Lane/Squeeze Past | 20 | 8.62% |

A total of 232 riders (23.5%) encountered an obstruction in their bike lane. Of these obstructions in a protected bike lane, 82.33% (191/232) were a car/vehicle and 17.67% (41/232) was garbage. A large majority of riders (87.93%) reacted by riding into the traffic lane (Table 2). A one-tailed chi-squared test (a = 0.05) was used to examine if Citi Bike riders reacted differently than non-Citi Bike riders when faced with an obstruction in their bike lane. The test returned a p-value of 0.3899. Another one-tailed chi-squared test (a = 0.05) was used to determine if motorized riders reacted differently than non-motorized riders to an obstruction in their bike lane. The resulting p-value for this test was 0.1043. Hence, both tests indicated no significant difference in how each of the groups reacted to an obstruction in their bike lane.

## Discussion

To our knowledge, this is the first study that enumerates and identifies types of micromobility vehicles in NYC bike lanes, distinguishes characteristics of these vehicles and their riders, and observes their reactions to bike lane obstructions. Notable in our findings is the large number of motorized micromobility vehicles observed. Four out of ten MMVs were motorized (40.28%). This surge in motorized MMVs and their presence in bike lanes may result in a concomitant increase in MMV-related injuries. New York City has instituted several recommendations and laws to promote rider safety such as appropriate speed limits, helmet use, and designated riding areas [30]. Further, the city has committed to installing cement barriers in place of existing plastic barriers within 20 of the 40 miles of designated protected bike lanes by the end of 2023 [30]. In light of this increased use of bike lanes by MMVs, what is not yet evident is the extent to which these policies will adequately promote the safety of riders and those around them within the protected bike lanes.

The low rate of helmet use across all types of MMVs is also notable with only one in four riders wearing one (25.9%). This rate was only slightly higher among motorized MMV riders (28.14%). Citi Bike riders were observed wearing a helmet far less frequently than riders of other bikes (8.81% versus 34.03%). This large difference in bike helmet use is consistent with findings from our prior studies [24, 25, 31], and indicates a need for outreach and education for CitiBike users and their lack of helmet use, which places them at substantially higher risk for head injuries.

Traumatic brain injuries (mTBIs) are one of the greater risks that may be encountered by MMV operators and can be accompanied by considerable health-care resource utilization [32] and costs [33, 34]. Varriano et al. found that bicycle-related mTBIs in men were three times as high as in women, and identified convenience and comfort as barriers to helmet use [35]. Sporri et al. found that while post-accident mTBI rates were similar in e-bike riders and cyclists, the riders of e-bikes were older and suffered greater craniocerebral trauma [36]. New York City law requires helmet use for those riding e-bikes that travel faster than 20 MPH, for delivery riders, and those under 18 years of age. Using a helmet can serve as a precautionary measure against mTBIs and concussions [37] and is recommended in NYC for slower motorized MMVs and bicycles. Our data suggest that most riders are not heeding this recommendation.

Observing how riders reacted to obstructions also yielded important findings. The overwhelming majority of riders rode immediately into regular motor vehicle traffic lanes as a response to obstructions. Moreover, the obstruction that was most commonly observed was a vehicle in the bike lane, a commonly reported issue in NYC [38]. More specifically, of the 232 riders who faced an obstruction in their bike lane, less than half of 1% (0.43%) reacted safely (stop and wait).

In addition to obstructions, additional potential hazards were the 21 motorcycle/dirtbikes observed in the bike lane. Not permitted by law to use the bike lane [18], the presence of these vehicles in this space warrants further investigation as well as vehicle and traffic law enforcement.

'Vision Zero' is an initiative implemented in cities across Europe since the 1990s and within the United States with the goal of eliminating traffic fatalities and injuries [39, 40]. Established in 2014, NYC's multi-pronged and data-informed *Vision Zero: Building a Safer City* has focused its efforts on the areas of engineering (such as street design), education and outreach, enforcement, and legislation [42]. This includes the city's installation and expansion of protected and dedicated bike lanes. Given the growing use of motorized MMVs and their presence in bike lanes, it would be beneficial to enhance data collection efforts that will give further insight into the (1) presence of motorized MMVs and obstructions in bike lanes, (2) safety behaviors of motorized MMV users, and (3) public's awareness of related vehicle and traffic laws.

The observations from this study paint a concerning picture of both obstructions and MMV safety behaviors of riders in protected bike lanes. As rates of MMV use continue to rise, so may implications for public health and safety. Our findings suggest that further research and local education, enforcement, and legislative efforts are needed to examine and implement best practices in the safe operation of MMVs, decreasing bike lane obstructions, promoting helmet use, and raising awareness of MMV legislation.

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**Code Availability** Not available.

## Declarations

**Conflict of interest** Not applicable.

**Consent to Participate** Not applicable.

**Consent of Publication** Not applicable.

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