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April 2, 2024

File: 0400-20

The Honourable Rob Fleming
Minister of Transportation and Infrastructure
PO Box 9850 Stn Prov Govt
Victoria, BC V8W 9T5
Via email: Minister.Transportation@gov.bc.ca

Dear Minister Fleming:

RE: REQUEST FOR AMENDMENT OF THE BRITISH COLUMBIA MOTOR VEHICLE ACT

At the March 13, 2024, Capital Regional District (CRD) Board meeting a Resolution was passed to advocate to the provincial government to consider amending the British Columbia *Motor Vehicle Act* (MVA) to allow electric wheelchairs, mobility scooters, and micro mobility devices, to operate in a safe manner in designated bike lanes and/or routes.

Previously, the CRD Board requested that the CRD Traffic Safety Commission (TSC) review e-bikes and micro-mobility as it relates to personal use and safety in the capital region. The TSC commissioned the University of Victoria to conduct a review which is attached. The review highlights that various elements influence the uptake, risks, and safety of micro-mobility devices. These factors include demographics and city infrastructure, and the broader implications of these devices on environmental sustainability and users' long-term health.

The review results demonstrate micro-mobility proves advantageous under safe and consistently enforced regulations. Optimal implementation of such regulations would entail a province-wide approach through an amendment to the MVA.

Thank you for your time and consideration.

Sincerely,

Colin Plant
Chair, Capital Regional District Board

Attachment

cc: CRD Board
Ted Robbins, Chief Administrative Officer, CRD
Kevin Lorette, General Manager, Planning and Protective Services, CRD

A REVIEW OF MICROMOBILITY DEVICES: IMPLICATIONS FOR USE AND SAFETY

Prepared for the Capital Regional District (CRD) Traffic Safety Commission

Ahneke van Lankvelt and Paweena Sukhawathanakul

University of Victoria

Introduction

Micro-mobility devices provide an alternative form of transportation that can play an important role in the future of sustainable transport along with enhancing accessibility and quality of life for users. This review examines the current literature on micro-mobility as it relates to personal use and safety. Micro-mobility in this review is defined as lightweight electric vehicles that are operated at low speeds such as electric scooters (e-scooters) and bikes (e-bikes). Findings from the review revealed that there are range of factors that affect the risks and adoption of micro-mobility devices including demographics (SES, age, geography) and city infrastructure, as well as the implication of these devices on the environment (sustainable production of components, reducing carbon emission/meeting climate action targets) and life-long health of users (physical activity and injuries).

Relevance to the Capital Regional District (CRD)

Micro-mobility and active travel are directly relevant to meeting the needs of the CRD. E-bike use accounted for 30 percent of all bike trips in the CRD in 2022 (R.A. Malatest & Associates Ltd., 2022) and active walking and bicycling modes of travel increased by 7 percent throughout the region from 2017 to 2022 (Litman, 2023). These findings highlight the growing adoption of active transportation. Additionally, the 2022 CRD travel survey indicated that many motorists want to rely more on walking, bicycling, and public transit if these options are affordable and accessible (Litman, 2023). The CRD recognizes the potential for active travel to help support sustainable communities, improve the physical and mental health of individuals, and reduce Green House Gas emissions (Ready Step Roll – Benefits of Active Travel CRD). A comprehensive understanding of the role of micro-mobility devices is applicable to the implementation of safety messaging, effective education, and secure navigation for individuals using micro-mobility on shared trails within the CRD.

Demographic Factors and Use of Micro-mobility Devices

The demographic of users contributes to the variability in the uptake and safe use of micro-mobility devices. Globally, studies have identified that individuals with higher educational attainment and SES are more likely to be early adopters of micro-mobility devices in particular e-bikes. For example, one study in Australia found that the most frequent bikeshare members were at the upper end of the pre-tax incomes above $A104,000 per annum (Fishman et al., 2014). Similarly, Popovich and colleagues (2014) found that e-bike users in California tend to have higher incomes and educational attainment. The cost of purchasing e-bikes can pose significant barriers to uptake. For example, a qualitative study in Norway found that high-costs was cited as a main barrier to purchasing e-bikes (Simsekoglu & Klockner, 2019). Another study of e-bike riders in China reported that cost savings – that is, anticipated money saved through using an e-bike for personal use over multiple years - was seen as the most critical motivation for purchasing an e-bike (Yasir et al., 2022). Despite the high costs of e-bikes being a barrier to purchase, emerging studies have reported that e-bikes may be economically accessible for those with lower SES. For example, a study on early-adopters of e-bikes in Austria found that the typical e-bike user in their study were 60 years or older, retired, and tend to have low incomes and levels of education (Wolf & Seebauer, 2014). In the Netherlands, a large-scale mobility survey found that among those who did not own an e-bike, those who had lower SES displayed more willingness to use an e-bike in the future (Plazier et al., 2022). Income differences have also been reported among users of different modes of micro-mobility sharing programs. Average monthly household incomes among shared dockless e-scooter users (i.e., where there are no designated places for devices to be returned), are substantially lower than users of docked and dockless e-bikes (Reck & Axhausen, 2021).

Other notable demographic considerations that influence micro-mobility use are gender, age and physical ability. Gender differences reported in studies tend to be mixed. While some studies report an even representation of men and women e-bike and e-scooter riders (e.g., Wolf and Seebauer, 2014, Haustein & Møller, 2016), the majority of studies found men to be overrepresented (Reck & Axhausen, 2021; Christoforou et al., 2021; Pazzini et al., 2022; Laa & Leth, 2020; MacArthur et al., 2014; Johnson & Rose, 2013). On the other hand, other studies in Denmark and the Netherlands cite women as a majority of e-bike users (Marincek & Rérat, 2020; Plazier et al., 2023). Another qualitative study conducted in the UK assessed gender differences in perceptions of barriers to e-bike and e-scooter use and found that females tend to cite fear as the predominant emotional barrier to using micro-mobility use which could contribute to the lower representation of women using e-bikes and e-scooters (Parnell et al., 2023). Furthermore, uncertainty around safety levels of micro-mobility seems to broaden the gender gap (Campisi et al., 2021).

Age differences have been reported among e-scooter and e-bike users. Among e-scooter users that were observed in Norway, users were most commonly between 18 and 35 years old (Pazzini et al., 2022) and other studies have also reported that the likelihood of e-scooter uptake is higher among younger users (Castro et al., 2019; Caspi et al., 2020; Laa & Leth, 2020). A study in Denmark found that e-bike users in the age category between 60 and 69 years of age were overrepresented (Haustein & Møller, 2016). However, The Dutch National Travel Survey from 2013 to 2017 found that the percentage of older adults within a similar age category was decreasing, with an increase in younger age groups adopting the e-bike. In studies that compared conventional bikes and e-bike usage, e-bikers are on average significantly older (Castro et al., 2019).

Age-related differences such as physical ability can also influence micro-mobility uptake. The appeal of using micro-mobility devices is that it provides an opportunity for users who have limited mobility to re-engage with active forms of transportation. For example, one study in North America found that 20% of respondents purchased an e-bike due to their reduced physical ability (MacArthur et al., 2014). Two general groups of e-bike users are often described in micro-mobility studies based on their physical abilities. One user group includes individuals who previously engaged in little physical activity levels and had no previous cycling experience (Sundfør & Fyhri, 2017); while the other group include individuals who have previous experience with cycling and are seeking the use of e-bikes to reengage with physical activity or to maintain/increase cycling levels (Marincek & Rérat, 2020). Among both groups, increased accessibility is often cited as a critical advantage to using e-bikes over conventional bikes as they can reduce barriers related to trip distance, topography, time and rider effort. Several studies highlight e-bikes' ability to enable individuals to ride more often, travel longer distances and carry more cargo with them; such as children or groceries (MacArthur et al., 2014; van Cauwenberg et al., 2018; Fishman & Cherry, 2016). With respect to the actual functionality and technology of the e-bikes as an incentive; speed capacity and mileage capacity was related to greater intentions of riders to adopt e-bikes (Yasir et al., 2022).

Lastly, with regards to the countries that were represented among these studies, studies primarily from Europe, Australia, and the USA report that micro-mobility was used mainly for leisure/recreation and commuting, with the goal of enhancing sustainable urban mobility. Cities such as Copenhagen, Munich, and Stockholm typically utilized micro-mobility for leisure and tourism purposes. On the other hand, Barcelona and Tel Aviv riders were more likely to cite commuting as a reason for using e-bikes. (Esztergár-Kiss & Lizarraga, 2021). The findings from a survey with 2092 users in the UK analyzed journey purposes of e-bikes and found that 40% of current e-bike users used them for commuting, 20% for work travel, and 91% of them responded saying they were used for other non-work purposes like exercise, fun, and touring (Melia & Bartle, 2021). Comparatively in many cities in China, there are more e-bikes in use than conventional bicycles (Cherry et al., 2016) and there is emphasis on their use for commuting because of their more reliable travel time especially during rush hour with increased traffic and congestion (Sun et al., 2023).

Infrastructure and Use of Micro-mobility Devices

Studies often cited infrastructure as being a critical promoting factor for using micro-mobility devices, noting the intersection between usage, comfort, and safety with availability of well-designed active transportation networks. Proper infrastructure is a prerequisite for encouraging the safe use of micro-mobility devices (Haustein & Møller, 2016). Findings from case studies on bike sharing systems and expansions of cycling networks in Lisbon support the role of supportive infrastructure in cycling (Felix et al., 2020). For example, the expansion of their city cycling network lead to a 3.5-fold increase in the number of cyclists using the network. Moreover, their implementation of a bike sharing system in the city resulted in a 2.5-fold increase in cyclists. Additionally, Dill and Voros (2007) found through phone surveys in Portland, Oregon that positive attitudes towards the availability of bike lanes were associated with greater desire to bike more and increased cycling trips. Increased levels of street connectivity also raised the number of cycling trips and minutes spent e-cycling per week in another study conducted in Germany (Brüchert et al., 2022). Finally, a study on greater

Copenhagen's upgraded bicycle superhighway infrastructure which added 855km found that the number of e-bike trips increased after the expansion (Rich et al., 2021). Altogether, supportive infrastructure can increase participation in modes of active transportation.

Infrastructure that supports micro-mobility also involves consideration of how weather conditions effect riders. Ma and colleagues (2019) reviewed weather, temperature, and road infrastructure as it relates to riding behaviours. They found an increase in risky riding behaviour in extreme weather conditions; for example, increased red light running with higher UV intensity. Weather mitigation strategies such as introducing sunshades at urban intersections significantly decreased risky riding behaviours.

Comfort and safety are two coinciding themes in the literature concerning micro-mobility. Proper infrastructure mitigates many comfort and safety concerns, and facilitates an easier transition to active transportation modes. For example, switching to e-bikes not only facilitates comfort but also decreases the need for facilities at trip end points like shower facilities at the workplace (MacArthur et al., 2014; Langford et al., 2017). Moreover, assessing comfort extends past micro-mobility users to pedestrians and road users as well. In a lab-controlled field experiment (Kazemzadeh & Bansal, 2021), pedestrian crowding levels were controlled while participants rode an e-bike on a bike path. They found that busier, more crowded cycling conditions were associated with decreased comfort particularly among young e-bike riders. The authors hypothesized that the increased need to overtake other cyclists and pedestrians, as well fewer opportunities for non-verbal communication between pathway users contributed to their discomfort. Infrastructure that allows for this sort of interaction could increase rider comfort. Other studies have also found that there was greater preference for e-cyclists to ride in protected and painted bike lanes. For example, Jones and colleagues (2016) found that e-cyclists in the Netherlands and the UK felt safer when cycling on the street as opposed to pathways with pedestrians because they were able to travel at a similar speed to the vehicles on the road. With e-scooter use, respondents in a New Zealand study expressed concern with riding on roads with heavy traffic but found busy footpaths also caused a high level of discomfort (Fitt & Curl, 2019). E-scooters seemed to fall in an awkward, intermediate speed category as they are too slow and wobbly alongside fast vehicular traffic but are too quick to be ideal for use alongside pedestrians. Protected bike lanes once again seemed to be a preference among e-scooter users. Thus, additional considerations for micro-mobility infrastructure include the need for cycling infrastructure to serve a wide range of micro-mobility vehicles including e-scooters.

Environmental Impacts

Conversations about the environmental effects of micro-mobility devices frequently revolve around their capacity to alleviate urban congestion, lower carbon emissions and Global Warming Potential (GWP), potential adverse environmental consequences of relocating shared micro-mobility fleets, and the production and recycling of the components of these electronic devices. Regarding sustainable urban mobility, micro-mobility has the potential to disrupt unnecessary short vehicle trips. For example, studies in Europe and Australia have shown that increased ownership of micro-mobility devices and where micro-mobility sharing programs have been implemented, congestion and traffic have been alleviated and emissions have been reduced (Masoud et al., 2019; Rabl & De Nazelle, 2012). Changes in traffic congestion have also been observed in larger cities. Case studies conducted on two large cities in China found that increased ridership in both e-bikes and conventional bikes contributed to less congestion within cities (Cherry & Cervero, 2007). Micro-mobility has been most effective in transforming transportation systems as first and last kilometer services. The first and last kilometer challenge is the notion that public transit or other modes of transit may be far from your starting point at home as well as far from your final destination at work or school etc. Thus, many people require an intermediate form of transportation like e-bikes and e-scooters. Investment in public transit and micro-mobility options helps to address this challenge (McQueen, 2021). These devices when used as a multi-modal transport option and through integration with public transit systems also help to reduce emissions (Shaheen et al., 2019). The devices support low carbon transport in cities because it is not just a replacement but an addition to other modes of transport when needed (Aartsma et al., 2020).

As micro-mobility options are a low carbon mode of travel, multiple studies highlight their ability to use less energy and create less pollution when compared to combustion engine vehicles (Abduljabbar et al., 2021). In the United States, e-scooter and e-bike sharing accumulated 45 million trips in 2018 (Şengül & Mostofi, 2021), potentially diverting use of transportation modes that produce carbon emissions. E-bikes emit 40 times less carbon dioxide compared to a car (Shao et al., 2012) and e-scooters can travel 128km with 1kW/h of energy as opposed to a car using fossil fuels which travels less than 1.6km using the same amount of energy. Similarly, with some of the best electric cars the same amount of energy only allows 6.4km of travel (Şengül & Mostofi, 2021). Furthermore, Hollingsworth and colleagues (2019) quantified the total environmental impacts of e-scooters using life cycle assessment and found that when e-scooter usage replaces personal car travel, in nearly all instances there is a net reduction in environmental impacts. Additionally, a case study conducted in the city of Bochum, Germany used quantitative environmental indicators to assess e-scooters and found that micro-mobility sharing services can reduce negative environmental impacts from other transportation systems (Severengiz et al., 2020). Specifically, the Global Warming Potential (GWP) of shared e-scooters was less than half of motorized individual transport options such as privately used cars, trucks, and motorised two-wheelers. Another study in China found that e-bikes yield lower environmental impacts per passenger kilometer than private vehicles using fossil fuels (Ji et al., 2012). A study examining life cycle CO_2 emissions in seven European cities revealed that the primary contributor to travel-related emissions was car travel, accounting for approximately 2.23kgCO_2/day. In contrast, life cycle emissions from cycling, which included a 4.5% share of e-biking in the sample, were significantly lower at only 0.03 kgCO_2/day (Brand et al., 2021). This study also found that the average person who changed their travel mode from using a car to using a bike, was able to decrease life cycle CO_2 emissions by up to 3.2kgCO_2/day. These studies collectively recognized the environmental benefits of active forms of transportation that include micro-mobility.

On the other hand, studies have also recognized common concerns with shared micro-mobility services in the context of environmental mitigation. Abduljabbar and colleagues (2021) note that the improper management of the devices in e-scooter sharing programs could lead to a net increase in emissions when there is a lack of proper policies addressing the collection, battery charging, and redistribution of the scooters. A quantitative study on the life cycle of e-scooters in North Carolina found that there are many burdens associated with the materials and manufacturing of the scooters as well as the hassle of transporting the scooters back to overnight charging stations (Hollingsworth et al., 2019). Their research found that low daily usage of the scooters as well as low scooter lifetime led to high global warming impacts due to manufacturing and materials burdens. They also found that specifically shared dockless e-scooters consistently result in higher life cycle global warming impacts in comparison to public transport and personal e-bikes but a decrease in global warming impacts when compared to individual car use. Comparing shared dockless e-bikes and e-scooters; e-scooters yield lower life cycle emissions. Another study used life cycle assessment in three case studies of electric scooters. Their results supported that the substitution of e-scooters for cars decreases GWP but the replacement of public transport or cycling lead to hardly any environmental benefits (Severengiz et al., 2021).

Durability of devices and battery technology are important considerations for the implementation of micro-mobility services. There are substantial emissions involved in the production of micro-mobility devices including battery manufacturing, swapping and maintenance. GWP has the potential to be decreased through battery technology innovations but only if implemented in a second life application because upgrading the batteries of e-scooters midway through their lifespan causes a 3% increase in GWP per passenger-km (Severengiz et al., 2021). First generation e-bikes used lead-acid battery technology which had many negative implications on the environment, but improvements caused a switch to Lithium-ion batteries (Li-ion; Şengül & Mostofi, 2021; Weinert et al., 2007). Some identified barriers to micro-mobility devices is the hidden cost of battery replacement and disappointment with manufacturers publicized battery range and performance (Jones et al., 2016). Additionally, areas for improvement involve safer charging and discharging, slower cell degradation, better operation in low and high temperatures and increased lifetimes of batteries. Weinert and colleagues (2007) interviewed 23 original e-bike equipment manufacturers and suppliers about maintenance issues and environmental concerns. In terms of maintenance, the manufacturers and supplied noted that new charging infrastructure is a not a requirement for personally owned e-bikes as batteries can be recharged from standard electrical outputs. However, a negative environmental impact was specifically reported among manufacturing power plants in China that were 75% coal-fired and produced lead emissions from poor battery production and recycling practices. They estimate that 30-70% of lead in the batteries were lost to the environment. Moreover, Fishman and Cherry (2016) reviewed a decade of e-bike research and found that e-bikes have been a large driver of increasing lead consumption in China. Therefore, while micro-mobility modes of transport lowers carbon emissions associated with traffic congestion, the negative environmental impacts stemming from negligent battery manufacturing, recycling, and disposal practices must be acknowledged to promote more sustainable use of these devices.

Life-long Health of Micro-mobility Users

As micro-mobility devices become more popular, it will be important to monitor the risk and protective effects of increased exposure on the health and well-being of users. Among health benefits, micro-mobility devices have the potential to reduce mobility barriers and expand the demographic of active transportation users without minimizing the health benefits associated with convention cycling. For example, one study that examined an e-bike rider's heart rate on a 5-kilometer road circuit, found that the rider's heart rate was maintained in the target range needed to reap cardiovascular benefits without lactic acid build up (Rose & Cock, 2003). This finding suggests that e-bike riders can avoid the fatigue and muscle pain that traditionally accompanies sustained active transportation habits on conventional bikes while still demonstrating cardiovascular benefits. Other studies have also found similar cardiovascular health benefits on the ebike compared to conventional bikes (Hoj et al., 2018; Simons et al., 2009), even though the total energy expenditure when cycling on an e-bike is 37 percent lower (van Cauwenberg & Deforche, 2018). Studies cite this reduced physical exertion associated with e-biking as a motivation for use and purchase of micro-mobility devices (Fishman & Cherry, 2016; Rose, 2011; Sundfør & Fyhri, 2017). When comparing the health benefit of e-bikes to conventional bikes, power demands from the e-bike user are lower than conventional bikes but they are still beneficial in terms of introducing active transport to sedentary individuals as often the lower power output is balanced by the longer trips taken while using an e-bike compared to conventional bikes (Langford et al., 2017). Longer trip distances among e-bike users were also reported in a sample of Dutch cyclists compared to users who use conventional bikes (van Cauwenberg & Deforche, 2018). Again, intensity levels on the e-bike surpassed the minimum needed to be health enhancing. Similarly, one study in Norway found that e-bike users accumulated more physical activity compared to conventional cyclists, with e-bike users increasing their bicycle use from 2.1 to 9.2 km per day on average (Sundfør & Fyhri, 2017). In sum, concerns surrounding lower physical exertion accompanying e-bikes is mitigated by the ability to take longer trips and reportedly higher levels of enjoyment (Fishman & Cherry, 2016; Langford et al., 2017; Jones et al., 2016; Castro et al., 2019).

Active transportation and micro-mobility options cater to the needs of an ageing population. The power assistance of these devices expands the demographic who choose active transportation methods. For example, individuals who experience discomfort riding a conventional bicycle in topographically challenging environments can achieve greater ranges of riding and maintain health enhancing physical activity with reduced effort on an e-bike (Rose, 2012; Fishman & Cherry, 2016). Topographically challenging terrain include longer distances, hills, and wind – all of which can be alleviated through the aid of micro-mobility devices (van Cauwenberg & Deforche, 2018; Jones et al., 2016). A study that interviewed the experiences and perceptions of e-bike owners in the Netherlands and United kingdom found that e-bikes were especially preferred by individuals who have limited mobility and those with a longer commute of 10km or more (Jones et al., 2016).

The most common risky cycling behaviours found to be associated with e-micro-mobility were the tendencies to occupy motor vehicle lanes, red light running, over-speed cycling, and riding in the improper direction to the flow of traffic. One study reported that reported than 90% of e-bike traffic accidents in their sample were caused by cyclists' risky riding behaviours including violations of traffic signals (Ma et al., 2019). However, in another study, e-bike riders perceived that there are more likely to obey road rules on an e-bike because the motor assistance allows them to come to a full stop and begin riding again (e.g., at traffic lights, stops signs etc.; Rose, 2012). A majority of studies highlight the prevalence and risk of high speeds that accompany e-bikes and e-scooters. E-bike users ride at higher speeds than traditional cyclists (Dozza et al., 2016; Schleinitz et al., 2015; Popovich et al., 2014). In particular, an observational study in Norway found that male e-scooter users aged 18-35 are the fastest users (Pazzini et al., 2022). The highest speeds were recorded on the road, second fastest in cycling lanes, and the slowest in pedestrian zones/the sidewalk. Another study found that, in general, people who were more excited about the higher speed and acceleration of e-bikes were more likely to ride in less safe manners which influenced the occurrence of collision (Haustein & Møller, 2016).

Micro-mobility users represent a vulnerable group on the road and misinterpreting the speeds of these devices can contribute serious accident risks. Haustein and Møller (2016) found that underestimation of e-bike speeds by other road users was the most common cause of incidents. The misinterpretation of speed stems from the cyclists' position on the bike and lower pedaling frequency related to the actual speed of travel which can surprise other road users. In this study they also found that the heavier weight of e-bikes compared to conventional bikes has been reported to affect older riders' ability to maintain balance. Moreover, evidence from Zhao and colleagues (2022) road injury analysis spanning samples in China, Japan, India, and the USA found that interactions with motor vehicles, rider error (related to high speed or intoxication), unintentional acceleration, loss of balance, and issues with the road surface were factors leading to high-risk situations on e-bikes.

Overall, there is an upward trend in micro-mobility injuries with variability among different demographic groups. Analyzing injuries specific to the use of e-devices is vital when weighing public health considerations and city planning. A recent review of injuries in the US found an increase in injuries and admissions from 2017 to 2018 associated with e-scooter use (Namiri et al., 2020). Impacts to the head, upper extremities and lower extremities are most common among e-scooter injuries, with the severity of such injuries tend to be mixed, according to existing reviews on the nature of e-scooter injuries (Toofany et al., 2021).

Age differences are commonly reported among studies that have examined micro-mobility-related injuries. Using road injury data, Zhao and colleagues (2022) found that adults older than 45 years of age in India, China, and the USA showed an increasing mortality and incidence rate related to micro-mobility. Specifically, using an Age-Period-Cohort analysis they found a more significant death and incidence rate related to use of micro-mobility devices in the under 25 and over 60 age group. A sharp rise was also identified in the ages from 10 years old to 24 which could be due to unsafe practices when operating such devices in the adolescent and young adult demographic.

Gender differences are reported in some studies but there are mixed findings. In one study, it was reported that older female riders sustained more severe injuries (Schepers et al., 2020). However, an injury analysis from an urban emergency department in Switzerland found that patients were predominantly male with a mean age of 47.5 and a main cause of injury identified as self-accident (Papoutsi et al., 2014). Self-accident was defined as being related to high speed, alcohol intoxication, etc. with more injuries in the head and neck region. Most of these incidences occurred in the morning (43.5%), 26.1% in the afternoon, and 17% in the evening. Greater number of injuries in the morning could be attributed to busier bike lanes and pathways on a morning commute. Nonetheless, while e-bike users were more likely to be involved in a crash requiring treatment at an emergency department, overall crashes on e-bikes were equally as severe as conventional bikes. Older adults were still highlighted as being at higher risk for more severe injuries but not a higher incidence rate (Haustein & Møller, 2016). These findings highlight the need for more tailored preventative measures that target different demographic groups of micro-mobility users.

Future Considerations

The emerging literature on micro-mobility highlights the utility of this mode of transportation in promoting physical activity while mitigating congestion. However, demographic variability, infrastructure, environment, and the health and safety of users are facets that impact the adoption of micro-mobility devices and effectiveness in urban contexts. Addressing these factors when making policies related to urban planning will be essential in promoting safe and accessible use. Considerations based on this review are provided in the table below.

	Considerations
Equity Focused Subsidies	• Offer subsidies and financial incentives reduce cost barriers for low-income population and ensures a wider range of demographics can access this mode of transportation. • Build equity into micro-mobility sharing programs to ensure affordability for all users (e.g., reduced pricing to low-income or other qualifying riders, affordable flat rates).
Diverse Active Transportation Infrastructure	• Prioritize bike lanes and paths, and facilitate integration with public transport (e.g., dedicated spaces for parking e-bikes and e-scooters at transit hubs). • Consider weather (e.g., sunshades and covered bike parking to encourage year-round use). • Ensure accessibility for individuals with physical limitation.
Environmental Impact Mitigation	• Battery recycling (e.g., regulations and incentives to ensure proper disposal and recycling and promotion of full first life use and second-life applications). • Ensure proper management and redistribution of shared micro-mobility fleet (e.g., placing responsibility on the bike/scooter sharing companies). • Provide support for innovations in battery technology, sustainability, and safety enhancements.
Safety and Education	• Promote rider education programs that address safe riding practices (e.g., riding in adverse weather conditions) especially for at-risk users. • Set effective speed limits. • Enforce traffic laws and regulations.
Injury Prevention and Data Collection	• Develop tailored safety regulations and targeted campaigns based on different demographics. • Collect data on micro-mobility injuries and conduct more analysis to fill in the gaps on injury trends for different areas and demographics. • Expand research on the relation between public health and active transportation infrastructure.

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