Battery-Powered Micro-Mobility and Canada's Health Sector – an introduction

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Canadian Coalition for Green Health Care

This report is part of a project which supports the Government of Canada's Zero Emission Vehicle Awareness Initiative's objective to increase public and industry awareness, knowledge and confidence in zero-emission vehicles (ZEV), particularly battery-powered micro-mobility (BPMM) solutions, as well as accelerate the adoption of these solutions by targeting the health and social services sector.

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Transportation in Health Care

Canada's health care system accounts for about five percent of total greenhouse gas (GHG) emissions in Canada. The largest share of emissions come from the supply chain, followed by the delivery of health care, and personal travel.[1]

Transportation of patients, staff, goods and services are vital to daily operations of Canadian hospitals. With an inextricable link between health and the environment, health care has a significant role to play in shaping sustainable cities. So, with over 2.6 million people employed by the Canadian health care and social service sector in 2022, supporting and promoting clean transportation has the potential to significantly decrease GHG emissions.[2]

Specifically, the Canadian health sector has potential, and some might argue the responsibility, to provide community leadership in the promotion and adaptation of technologies and practices, which will improve planetary health. As one of the most trusted professions, health care workers are essential influencers on societal issues and have an important part to play in the transition to a sustainable, fairer, resilient, and healthier world.[3] The ethical mantra of the health care community to 'Do No Harm' should extend beyond the patient and include reducing harm to the environment.[4]

By adopting practices such as clean transportation, health care workers and organisations are proactively contributing to efforts to protect the environment and reduce harm caused by the climate crisis. Battery-powered micro-mobility (BPMM) is an emerging area of clean transportation that has the potential to enhance the transition in urban environments and personal travel in the health care field. This report will inform the health care sector with regards to the current landscape of BPMMs and its various environmental, health, practical, social, and financial impacts to support program development and advocacy.

Overview of Battery-Powered Micro-Mobility

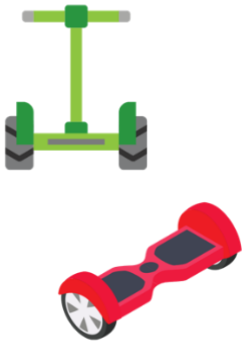
BPMM refers to a range of small, lightweight battery-powered vehicles, usually travelling at speeds below 32 km/hr. It is meant to occupy space alongside regular bicycles, and is not suitable for pedestrian sidewalks or highways.[5] Further, it represents a subset of micro-mobility vehicles that include human-powered vehicles.

[1] Tennison et al., "Health Care's Response to Climate Change."
[2] Government of Canada, "Employment by Industry, Annual."
[3] Kurth and Potter, "The Public Health Crisis Is Planetary—and Nursing Is Crucial to Addressing It."
[4] Doctors for Planetary Health - West Coast, "Taking Action."
[5] Zarif, Pankratz, and Kelman, "Small Is Beautiful."

Examples of BPMMs include electric scooters (e-scooters), electric bikes (e-bikes), electric cargo bikes and electric rickshaws/trishaws, powered self-balancing boards, powered skates, and skateboards/non-self-balancing boards (Table 1).[6] E-scooters have no more than three wheels, a platform to stand on, a handlebar for steering, and an electric motor propelling the vehicle, without human propulsion, usually no more than 24 km/hr.[7] E-bikes are bikes equipped with an electric motor that can be activated through pedaling (pedal-assist) or a small button/lever on the handlebars (throttle-assist).[8] Cargo e-bikes are e-bikes built/retrofitted to carry a cargo box at front or back. Rickshaws/trishaws are bikes with an attached two- or three-wheeled passenger cart, typically designed for carrying passenger. Both e-scooters and e-bikes vary in size, model, styles, and speed capabilities.

This report will not cover vehicles used for vocational purposes or commercial goods/services delivery, (e.g., motorized wheelchairs and personal mobility vehicles) as these vehicles already have well-defined regulatory, roadway design, and injury reported frameworks in place.

Table 1. Examples of common micro-mobility vehicles

Electric standing or sitting scooters (e-scooter)	**Electric bicycle (e-bike)** **(e.g., cargo bikes, rickshaws, pedal-assist, throttle-assist)**	**Other** **(e.g., self-balancing boards, powered skateboards)**
		

Images courtesy of Canva. https://www.canva.com/

[6] "Defining Micromobility - Institute for Transportation and Development Policy."
[7] "Electric Kick-Style Scooters (e-Scooters)."
[8] Norman, "What Is an Electric Bike and How Do They Work?"

Regulations in Canada

In 2000, Canada's Motor Vehicle Safety Regulations (MVSR) defined power-assisted bikes as a separate category, according to the definition below:[9]

> Motor Vehicle Safety Regulations (Canada) (C.R.C., c. 1038):
> Interpretation 2. (1) "Power-assisted bicycle" means a vehicle that:
> (a) has steering handlebars and is equipped with pedals,
> (b) is designed to travel on not more than three wheels in contact with the ground,
> (c) is capable of being propelled by muscular power,
> (d) has one or more electric motors that have, singly or in combination, the following characteristics:
> (i) it has a total continuous power output rating, measured at the shaft of each motor, of 500 W or less,
> (ii) if it is engaged by the use of muscular power, power assistance immediately ceases when the muscular power ceases,
> (iii) if it is engaged by the use of an accelerator controller, power assistance immediately ceases when the brakes are applied, and
> (iv) it is incapable of providing further assistance when the bicycle attains a speed of 32 km/h on level ground,
> (e) bears a label that is permanently affixed by the manufacturer and appears in a conspicuous location stating, in both official languages, that the vehicle is a power assisted bicycle as defined in this subsection, and
> (f) has one of the following safety features,
> (i) an enabling mechanism to turn the electric motor on and off that is separate from the accelerator controller and fitted in such a manner that it is operable by the driver, or
> (ii) a mechanism that prevents the motor from being engaged before the bicycle attains a speed of 3 km/h;

On February 4th, 2021, Transport Canada repealed their regulation and definition of BPMM leaving it up to each province and territory to define the different types of e-bikes and micro-mobility vehicles permitted and to put in place rules governing users.[10]

Currently, regulations for e-bikes vary across Canadian provinces and territories. Similarly, regulations governing e-scooters and other micro-mobility vehicles also vary. Quebec permits scooters on public roads as part of a three-year pilot project.[11] British

[9] Norman.
[10] Canada, "Importing Non-Regulated Vehicles."
[11] The Canadian Press, "Quebec's New e-Scooter Rules."

Columbia permits electric kick scooters in specific cities.[12] Alberta prohibits private e-scooters in specific cities but permits shared e-scooters.[13] Manitoba has yet to include e-scooters in their *Highway Traffic Safety Act while,*[14] Ontario[15] and Saskatchewan[16] are allowing municipalities to determine specific regulations.

The regulating of micro-mobility vehicles requires stakeholder agreement regarding the classification of specific vehicles and whether tailored regulations for speed and operation should be implemented.

For a full list of rules and regulations in Canadian Provinces and Territories, view this fact sheet: https://greenhealthcare.ca/wp-content/uploads/2024/03/55-23-BPMM-Incentives-Rebates-FINAL-EN.pdf

Current Landscape of BPMMS

Overall, the Canadian e-bike market is estimated at $33.76 million USD in 2024, with an expected increase to $86.27 million USD by 2029. This equates to a compound annual growth rate of 20.64% for 2024-2029. The current Canadian market is dominated by pedal-assisted e-bikes at 80.10%.[17] This expanding market will create a variety of job opportunities from manufacturing and assembly to sales and maintenance.

The presence of BPMMs in Canada take form in private ownership and shared programs. Several provinces implemented shared e-scooter and e-bike programs. In 2022, over 1,000 e-scooters were deployed across participating cities in Ontario, including Ottawa and Hamilton, with approximately 100,000 rides taken during the pilot period.

Other provinces like British Columbia, Alberta, and Saskatchewan also implemented pilot programs for e-scooters and e-bikes in partnership with companies such as Lime Technology, Mobi by Shaw Go, and Neuro Mobility.[18] BIXI, a bike-sharing program in Montreal, has the largest fleet of e-bikes in Canada with 2,395 e-bikes and 184 electric charging stations with e-bikes being used 24% more than conventional bikes.[19] However, pilot programs in Oshawa, Ontario and Kelowna, British Columbia terminated their pilot e-scooter programs due to concerns regarding rider safety and improper usage.[20]

[12] Province of British Columbia, “Operating Your Electric Kick Scooter Safely.”
[13] Riebe, “Despite Surge in Popularity, Private e-Scooters Still Banned on Edmonton Streets.”
[14] Modjeski, “E-Scooter Advocate Wants Regulations as Device’s Popularity Grows in Winnipeg.”
[15] “Electric Kick-Style Scooters (e-Scooters).”
[16] “SGI Changes Regulations to Allow E-Scooters on Roads, as Long as Municipalities Pass a Bylaw”; City of Saskatoon, “Shared E-Scooters.”
[17] Mordor Intelligence, “Canada E-Bike Market Size & Share Analysis - Industry Research Report - Growth Trends.”
[18] “Micromobility 2023 Update.”
[19] BIXI Montreal, “Another Record-Breaking Season for BIXI with 9 Million Trips Taken in 2022.”
[20] “Micromobility 2023 Update.”

Stakeholder perspectives

As the market grows, the adoption of BPMMs will depend on how positively and robustly it is embraced by users, manufacturers, local communities and other stakeholders. For BPMM users, ridership depends on the benefits BPMMs bring to their lifestyle and commute efficiencies. In a three-year qualitative study of novice e-bike riders (N=11) from Kitchener, Ontario, riders cited e-bike benefits related to using it as commuter vehicle (replacing car sometimes), reducing a need to shower at work (due to minimal exertion), using less overall effort compared to conventional bikes, a more enjoyable commute time, motivations for healthier lifestyle, and less conflict with cars. However, riders also stated difficulty peddling when the battery was dead, less exercise when e-biking, difficulty remembering to charge the battery, loss of recreational value, and fearfulness of doing one's own repairs.[21]

Overall, BPMM users perceived e-bikes to be better for the environment compared to cars but had concerns regarding riding in the winter months, sharing road infrastructure with motorists, a lack of bike infrastructure (i.e., bike lanes), and conflicts with conventional bike users and pedestrians. Other BPMM industry stakeholders including retailers, manufacturers, cycling coalitions, and government agencies have a role to play in the adoption of BPMMs. In a survey of 116 e-bike industry stakeholders from British Columbia, it was agreed that pedal-assist e-bikes should be regulated the same as conventional bikes and allowed to operate on mixed-traffic roads, bike lanes, unpaved off-road trials, shared-use pathways, and sidewalks. Regulating speed was the most supported, followed by age restrictions and licensing. Industry stakeholders agreed that e-bikes aids with riding on hilly terrain, helps riders with physical limitations, and allows longer distance trips.[22]

Both BPMM users and industry stakeholders highlight the benefits of using BPMMs for commuting but also recognize specific barriers and limitations that should be considered. Understanding stakeholder and user perspectives provide better direction and input for policy development regarding BPMM usage, and will, ultimately, support the successful implementation and adoption of BPMM programs in the health care sector.

Incentive/Rebates Programs

Incentives and rebates for BPMM are important for the overall accelerated adoption of BPMMs and reducing known barriers. The most common types of incentive programs include monetary rebates for purchasing a BPMM, coupled with other incentives for training or rentals, or general cycling promotion through improved biking infrastructure

[21] Edge et al., "Exploring E-Bikes as a Mode of Sustainable Transport."
[22] Aono and Bigazzi, "Industry Stakeholder Perspectives on the Adoption of Electric Bicycles in British Columbia."

and sharing programs.[23] The development of incentive programs involves determining eligibility, administration, and appropriate rebate amounts. Currently, in Canada, several municipal, provincial, and territorial governments support rebate programs, including Nova Scotia, PEI, Yukon, British Columbia, and Alberta.[24] For a full list of available incentives/rebates, view this fact sheet: https://greenhealthcare.ca/wp-content/uploads/2024/03/55-23-BPMM-Incentives-Rebates-FINAL-EN.pdf

An important aspect to consider in the development of rebate and incentive programs is environmental justice. For example, the CalEnviroScreen program in Oakland, California uses an environmental justice index to ensure an equitable transition for the electrification of transportation. Recognizing that electric vehicles remain largely inaccessible for low-income and BIPOC (Black, Indigenous, and Other People of Colour) communities, the authors created a decision layer to identify priority areas for focused interventions such as "new EV incentives," "trade-in EV incentives," or other support programs for private electrification of vehicles.[25]

Evidence-based Impacts of BPMMs

Understanding the environmental, practical, health, social, and financial impacts of BPMMs will be crucial for implementing fair and appropriate BPMM policies and regulations. The following sections will review current research on these impacts, but the reader is encouraged to conduct additional research to better understand how they fit with their own individual personal or organisational needs.

Environmental Impacts

Transportation is one of the largest sources of GHG emissions in Canada. In 2021, the transport sector was the second largest source of GHG emissions, accounting for 22% of total national emissions (150 megatonnes (MT) of carbon dioxide equivalent (CO_2e)) and passenger vehicle transportation (cars, light trucks, public transportation etc.) accounting for 57% of the total transportation-related emissions.[26] To reduce Canada's overall environmental impact, BPMM and other forms of micro-mobility can be an effective alternative to passenger vehicles. BPMM offers a viable option for those with a daily commute range of 10-50km, which aligns well with, for example, Toronto's average commute distance of 12.3km, which is the longest average commute in Canada.[27]

[23] Bigazzi and Berjisian, "Modeling the Impacts of Electric Bicycle Purchase Incentive Program Designs."
[24] Yakub, "A Guide to Electric Bike Rebates and Bike-Sharing Options in Canada."
[25] Ku, Kammen, and Castellanos, "A Quantitative, Equitable Framework for Urban Transportation Electrification."
[26] Canada, "Greenhouse Gas Emissions."
[27] Osaman, "Toronto Ranks in Top Three for Longest Commute in the U.S. and Canada."

To truly measure and compare the environmental impact of different modes of transportation (e.g., walking, biking, BPMM, public transportation), the most common way is to calculate the life-cycle emissions associated with a specific means of transportation. For vehicles, this includes emissions from all aspects of the vehicle's life-cycle including the production (e.g., raw material extraction, transport of raw materials, and manufacturing), use (e.g., vehicle use, maintenance, repair, and docking infrastructure use, maintenance and repair), and end-of-life (e.g., dismantling and deconstruction, waste processing, and disposal). Specifically, for BPMM, there are additional concerns related to the raw material extraction for batteries and the disposal of batteries.

Research shows that using micro-mobility reduces an individual's GHG emissions compared to more energy intensive modes of transportation. When comparing life-cycle emissions across modes of transportation, cyclists in seven European cities produced 84% less CO2 emissions compared to non-cyclists. When shifting from car to biking, life-cycle CO2 emissions from travelling decreased by 67%.[28] In 2020, the life-cycle emissions of a personal e-bike was 40 grams CO2e/mile, which is 11.5 times less than a personal combustion vehicle, as seen in Figure 1.[29] Since e-bikes and conventional bikes do not use fuel, their life-cycle emissions is significantly less than vehicles fueled by diesel or gasoline engines.

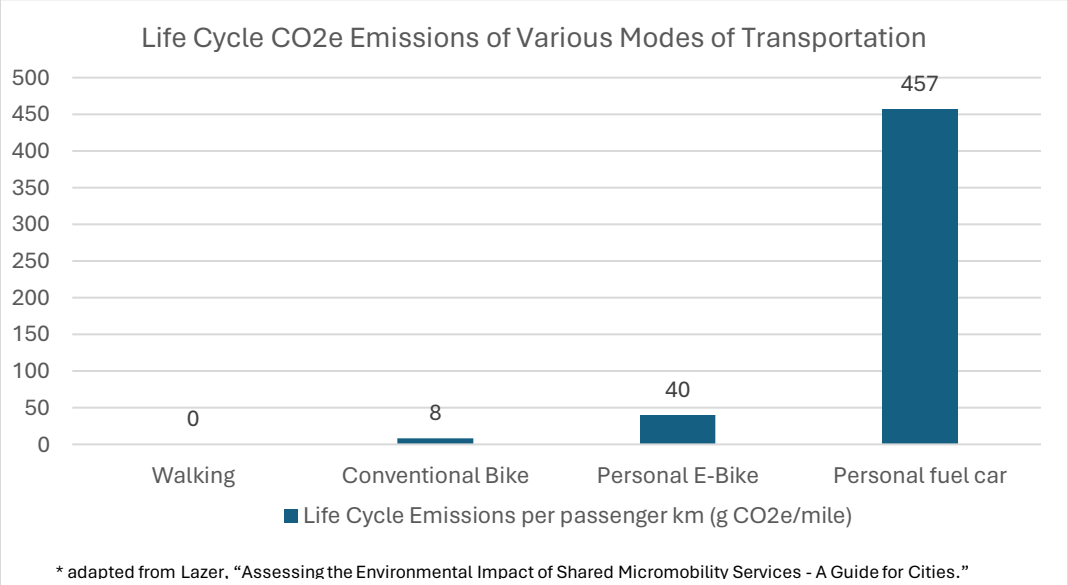


Figure 1. Life-Cycle CO2e Emissions of Various Modes of Transportation

There is also, claim some, a difference between the environmental impacts of shared BPMM (i.e., BIXI bike share) and personal BPMM usage. A study found that, in the short-

[28] Brand et al., "The Climate Change Mitigation Effects of Daily Active Travel in Cities."
[29] Lazer, "Assessing the Environmental Impact of Shared Micromobility Services - A Guide for Cities."

term, only personal e-bikes and e-scooters made transport more sustainable, with CO2 emissions of personal e-bikes (34g CO2/per passenger kilometre (pkm)) and personal e-scooters (42g CO2/pkm) lower than the average CO2 emissions of the modes they replace (88g CO2/pkm and 58g CO2/pkm) (substituted modes include car, public transport, and non-electric bike). Whereas shared e-bikes and e-scooters actually emitted more than the transport modes they replace.[30] Shared micro-mobility has greater life-cycle emissions compared to personal usage due to the electricity required to charge micro-mobility vehicles at docking stations and the larger auxiliary vehicles used to transport shared micro-mobility devices across the city for charging, maintenance, or rebalancing.

When an individual chooses to use BPMM, they are by default not using cars, public transit, or conventional bikes, which have varying GHG emissions. So, it is important to understand what modes of transportation BPMM are replacing and the resultant net GHG emissions from travel. If an individual uses BPMM instead of walking or using a conventional bike, the net GHG emissions for that trip would increase. However, if an individual uses micro-mobility instead of an internal-combustion vehicle or diesel bus, the net GHG emissions for that trip would decrease. This analysis focuses on one mode of transportation for each trip.

Net GHG emission reductions resulting from introducing BPMM are seen across various cities. In 2019, Portland, Oregon experienced a net 34% reduction in GHG emissions because of introducing e-scooters.[31] Between London and New York City, 484 metric tons of CO2 emissions per day could be saved due to residents taking more trips by e-bike.[32] BPMM is estimated to replace 18% of short car trips, which is especially useful in cities and dense urban areas where short car trips contribute to emissions. Specifically, shared e-bikes produce 0.15 metric tons CO2, whereas light-duty vehicles produce 5.29 metric tons CO2 for the same trips.[33]

Comparing the environmental impacts of various modes of transportation show that electrification should be considered a viable option for reducing the GHG emissions of the transportation sector. This can be seen as a more cost-competitive solution as the demand grows for renewable energy. Renewables provided more than 27% of global electricity generation by the end of 2019 and is becoming increasingly cost-competitive

[30] Reck, Martin, and Axhausen, "Mode Choice, Substitution Patterns and Environmental Impacts of Shared and Personal Micro-Mobility."
[31] Lazer, "Assessing the Environmental Impact of Shared Micromobility Services - A Guide for Cities."
[32] McQueen et al., "Transportation Transformation."
[33] Fan and Harper, "Congestion and Environmental Impacts of Short Car Trip Replacement with Micromobility Modes."

with some regions having lower cost renewable energy than fossil fuels.[34] Alternative forms of transportation, particularly BPMM, can be a significant tool to reduce personal vehicle emissions, and in the context of health care, emissions generated from staff or patient travel to and from health care facilities.

Practical Impacts

When discussing the daily adoption of BPMMs within a community, practical impacts such as efficiency and convenience related to weather, safety, storage, and manufacturing are important considerations. These considerations may be particularly relevant to the health care community with staff and patients requiring various travelling accommodations.

Commuting Efficiency

In dense urban areas, BPMMs can reduce travel times by avoiding congestion. In a case study in Seattle, Washington authors utilized simulation models to analyze the impacts of replacing short car trips with micro-mobility vehicles on traffic congestion. Results of the study found that when 10% of short car trips were replaced by micro-mobility, the number of routes across the city with moderate and severe congestion decreased by about three percent and one and a half percent, respectively, while speeds on most roadways increased between zero and one percent.[35] If bike lanes were sufficiently implemented, there would be an over five percent decrease in congestion of street intersections.

Specifically for health care workers, commute time with active transportation (15.5 mins), which includes micro-mobility, saved around five minutes compared to commuting with a car, truck, or van (21.6 mins), when comparing the average commute time in North America in 2022.[36] This is exemplified in the City of Bogotá, Colombia study where health care workers were provided access to BPMMs to commute to work during the COVID-19 pandemic. Since health care workers relied heavily on public transportation that was shut down due to COVID-19, BPMMs provided an efficient alternative to public transportation while reducing contact with others.[37] Due to the success of the pilot, the city considered providing health care workers with permanent access to e-bikes, increase availability of secure parking places for BPMMs, and expanding infrastructure for safer and faster routes.

[34] Bogdanov et al., “Low-Cost Renewable Electricity as the Key Driver of the Global Energy Transition towards Sustainability.”
[35] Fan and Harper, “Congestion and Environmental Impacts of Short Car Trip Replacement with Micromobility Modes.”
[36] Government of Canada, “Main Mode of Commuting by Commuting Duration, Time Leaving for Work, Industry Sectors, Occupation Broad Category and Gender.”
[37] “Bogotá Company Deploys 400 Free E-Bikes to Help Health Workers Respond to COVID-19 |.”

Space Efficiency

BPMMs are more space efficient than cars in terms of parking and travel space. The parking space required for BPMMs is significantly less than the space required for a car Approximately ten e-bikes could fit in the parking space of one car.[38] Research also finds that in a six km round trip with eight hours of parking, bikes take up 9.5 m^2/h compared to 90.4 m^2/h of a single driver, on-street parking, passenger car.[39]

For health care organisations, replacing parking spots with BPMM storage could increase the number of staff and patients who are able to park closer to the hospital instead of parking on adjacent streets or private parking lots.[40] Increasing BPMM storage and reducing parking space could promote shifts to active transportation and alleviate parking demands amongst patients, particularly those of the aging population and those who cannot use active transportation.

Weather conditions

The use of BPMMs is dependent on the ability to ride with ease and without stress, which is a concern for those living in areas of varying seasonal weather conditions. Research finds that there are reduced numbers of shared e-scooters, dockless e-bikes, and docked bikes trips in colder, rainier, and windier conditions, as well as extreme heat and high relative humidity.[41] Focused promotion, resources, or guides on riding in different weather conditions will be crucial to promoting BPMM usage in seasonal areas.

For BPMM batteries in particular, weather is an important consideration to prevent damage which could result in potential safety hazards and battery failure. It is recommended BPMM batteries not be charged or stored in temperatures below freezing or above 30°C which could cause deterioration.[42] Weather conditions is an important consideration for the selection of appropriate BPMM storage.

Safety Concerns

There is increased concern with respect to injuries related to BPMM use in urban settings and potential risk for public safety. With a rise in e-bike usage, there has also been an increase in reports of serious injuries with the use of micro-mobility.[43] According to the National Electronic Injury Surveillance System in the United States, there were 133,872 injuries involving e-bikes/e-scooters between 2017 and 2000 in America, with injury rates

[38] Yanocha and Allan, “The Electric Assist: Leveraging E-Bikes and E-Scooters for More Livable Cities.”
[39] “Micromobility, Equity and Sustainability Summary and Conclusions.”
[40] Pendakur and Roer, “Access and Parking Criteria for Hospitals.”
[41] Noland, “Scootin’ in the Rain.”
[42] “Important Usage, Storage and Safety Information for Lithium Batteris.”
[43] Blomberg et al., “Injury from Electric Scooters in Copenhagen.”

higher between 2013-2017 correlating with an increased use of these vehicles.[44] In a study of e-scooter use globally, it was found that injuries were mostly minor, but there have been cases that required operative intervention. Injuries were mostly attributed to lack of helmet use, alcohol consumption, or user positioning affecting their ability to respond in a crisis situation.[45]

While cases of injury are not to be taken lightly, certain interventions can be taken to help increase safety. Riders should be required to wear appropriate safety gear including a protective helmet and if possible, elbow and knee pads. In addition, education on the proper use of equipment, never riding under the influence of drugs or alcohol, and making sure that there is no damage to the vehicle before using can all help ensure the safety of the rider and those in the immediate vicinity. Furthermore, the implementation of lanes and paths dedicated to micro-mobility would allow riders to feel safe away from cars and protect pedestrians from potential collisions.

Other safety concerns include electrical hazards, fire hazards, and human-caused hazards. Electrical hazards include battery-charging issues, battery short-circuiting, and braking issues. BPMM vehicles are powered by lithium batteries, and while the risk associated with certified Underwriters Laboratories lithium batteries is minimal under normal conditions, education on proper storage and charging is essential to minimize any potential risks. Although user safety concerns are of the utmost importance, many users are also concerned about safe storage options and overall maintenance of their vehicles. Maintenance can include lubrication, tire inflation, brake pads, and battery care, which can introduce more costs for the usage of the vehicle.[46] For more information on proper use and storage of lithium batteries and BPMM vehicles, visit the Canadian Electric Bicycle Association website: https://cebassociation.com/important-usagestorage-and-safety-information-for-lithium-batteries/.

Health Impacts

For the health care sector, the impact of BPMMs on human health can be a significant driver for decision making. BPMM usage has both direct and indirect benefits to physical and mental health.

[44] Yahya et al., “Trends in the Incidence and Severity of Injuries Sustained by Riders of Electric Bikes and Powered Scooters.”
[45] Schneeweiss, Hassan-Ali, and Kam, “Safety And Risk Factors Associated With Electric Scooter Use Globally.”
[46] “What Type of Maintenance Does an E-Bike Need?”

Physical Health

Studies show that e-biking provides physical activity of at least moderate intensity, which is in between walking and conventional biking. E-biking can thus contribute to meeting physical activity recommendations and increasing mean physical activity per week.[47] Specific increases have been seen in cardio-respiratory health, related to maximum oxygen consumption.[48]

E-biking can, in particular, improve fitness levels for those who experience low physical activity.[49] The pedal assist and throttle features allow BPMM devices to be accessible to a wide range of the population, presenting opportunities for aging individuals, those with low-mobility or certain medical conditions (such as arthritis, obesity ,etc.) to participate in physical activity that is low-impact and can be tailored to their specific needs and capabilities.[50]

In addition to direct health benefits, there are several indirect health benefits, related to reduced air pollution. As discussed in the environmental impacts section of this report, shifting towards alternatives modes of transportation, including BPMM, would reduce traffic emissions, and thus air pollution. Research conducted post COVID-19 pandemic suggests there was a significant reduction of airborne nitrogen dioxide because of the reduction in traffic emissions.[51] Reducing air pollution can indirectly reduce negative associated health impacts such as increased risk of chronic obstructive pulmonary disease, asthma, bronchiolitis, lung cancer, cardiovascular events, central nervous system dysfunctions, and cutaneous disease.[52] Replacing noisy fuel-engine vehicle trips with electric modes can also reduce noise pollution, which contributes to health problems overtime related to hearing loss, sleep deprivation, and learning issues in children.[53]

Mental Health

BPMM usage can also contribute to increases in mental health and wellbeing. In a Spanish study of 294 commuters, those who used active transportation or public transport spent less time and money commuting to work, which was associated with a decrease in levels of worry about sleep loss, being stressed, and feelings of unhappiness or depression.[54]

[47] Abduljabbar, Liyanage, and Dia, “The Role of Micro-Mobility in Shaping Sustainable Cities.”
[48] Bretones and Marquet, “Riding to Health.”
[49] Bourne et al., “Health Benefits of Electrically-Assisted Cycling.”
[50] Pasquali, “Benefits of theE-Bike.”
[51] Barua and Nath, “The Impact of COVID-19 on Air Pollution.”
[52] Manisalidis et al., “Environmental and Health Impacts of Air Pollution.”
[53] Raja, Sriraman, and Kameswaran, “Noise Pollution and Associated Hearing Loss in a Metropolitan City—a Preliminary Report”; Sohrabi et al., “Health Impacts of COVID-19 through the Changes in Mobility.”
[54] Garrido-Cumbrera et al., “Can the Mode, Time, and Expense of Commuting to Work Affect Our Mental Health?”

A case study on the "Cycling Without Age" Program at Hillside Pines Home for Special Care in Bridgewater, Nova Scotia, illustrates the positive mental and emotional benefits of BPMM for older adults.[55] Launched in June 2022, the program utilizes battery-assisted trishaws from Van Raam in the Netherlands as an accessible recreational vehicle for the residents to ride around on. A satisfaction survey of 83% of participants found it was a very good and enjoyable activity. It was found particularly beneficial for individuals who suffer from Alzheimer's and 'reactive' behavior because they often end up in calmer, clearer, and more positive states of mind when they return from the rides.

Social Impacts

BPMMs can increase accessibility to health care by alleviating mobility deserts, which are characterized by poor options for public or active transportation. These devices offer a solution to the first-mile/last-mile challenges of urban transportation systems, including reported problems of getting to public transportation and getting from public transportation to a destination. A 2021 study in Washington D.C. and Los Angeles, California attributed marginalized communities' preference towards e-scooters to the desire to find solutions for connecting public transit to their destination, also known as the last-mile.[56]

For marginalized communities to receive the benefits of BPMM sharing programs, it is important that policies and implementation activities ensure an equitable distribution of these services. In some cities, although there was an overall increase in BPMM programs, a higher proportion of racialized individuals were less likely to have access to both e-bikes and e-scooters.[57]

One way to ensure equitable access to BPMM programs is for municipalities and institutions to work with BPMM companies to find ways to support program use among marginalized populations. For example, the City of Baltimore, Maryland requires rental companies such as Lime and Bird to offer reduced-cost riding plans to low-income customers, to not require credit cards or smartphones for payment, and to place a quarter of e-bikes and e-scooters in neighborhoods where more than 40 percent of households earn less than $25,000.[58] These type of programs reduce barriers to payment and increase access to BPMMs.[59] Similarly, private companies like TIER mobility have partnered with Omni in Bordeaux, France to provide wheelchair-accessible e-scooters,

[55] Waddington, "Ice Cream Tastes Better in a Trishaw."
[56] Yan et al., "Evaluating Shared E-Scooters' Potential to Enhance Public Transit and Reduce Driving."
[57] Aman, Zakhem, and Smith-Colin, "Towards Equity in Micromobility."
[58] Campbell and Richman, "After Problems with City Bike Share Program, Baltimore Turns to Lime and Bird."
[59] Kempler, "E-Scooters and Micromobility Are Potential Public Health Game Changers for Transportation and Equity."

which allows for 1.4 million wheelchair users in Paris with improved access to micro-mobility, who may not have had opportunities to use BPMMs otherwise.[60]

Increased access to diverse modes of transportation also supports social inclusion. An e-bike can be used by the elderly, an individual with a physical limitation, or someone who does not have the stamina or capability to ride a conventional bike; allowing them to maintain social networks, ride with other micro-mobility users, and have conversations without falling behind and feeling excluded.[61]

Financial Impacts

On the individual level, costs related to owning an e-bike include initial investment, ongoing battery charging fees, storage, and maintenance fees. In 2021, the average cost of a basic commuter e-bike was $1,250-$5,000 CAD. [62] With all costs and fees included, when compared to the average cost of a second-hand car ($33,750 CAD), BPMM devices represent significant cost savings.

Maintenance for an e-bike includes annual tune-ups, new tires, brake pads, and battery replacements every two to five years. Over five years, maintenance can cost $943/year CAD. However, for a car, maintenance costs can add up to $1,500 - $2,000/year CAD.[63] Most cities also have free designated parking for e-bikes, while daily parking rates for cars can be up $20-30day.[64] Other costs related to owning a car include insurance, car payments (interest and principal), and licenses. Unlike other vehicles, BPMMs are not legally required to have insurance in Canada. Some home insurance policies may provide limited coverage for theft, damage, or liability, but any additional coverage would have to be customized with a home insurance agent.[65] Overall, there are lower upfront, energy, and maintenance costs compared to owning a car.

For local communities, investments into BPMM infrastructure supports economic prosperity. Parking spaces set aside for bikes and e-bikes were found to deliver five times the retail spend per square metre than the same area of car parking while individuals who cycled took more trips to local town centres compared to those who used car.[66] Increased micro-mobility infrastructure increases traffic to the area and the dollar value of contributions to the local economy.

[60] Heathman, “Making Micro-Mobility Services More Accessible for Disabled People.”
[61] Pasquali, “Benefits of theE-Bike.”
[62] “The True Cost of Investing in an E-Bike | Momentum Canada.”
[63] “What Is the Total Cost of Ownership for a Car?”
[64] “The True Cost of Investing in an E-Bike | Momentum Canada.”
[65] Friskney, “How to Insure E-Bikes and Motorized Scooters.”
[66] Hernandez, “Revitalizing Communities.”

Conclusion

BPMM is a rapidly expanding transportation technology and a viable, convenient, clean method of transportation. Analyzing the environmental impacts of BPMM and micro-mobility more broadly requires us to consider a high number of variables compared to other types of transportation. However, overall research demonstrates a direct reduction in GHG emissions when shifting to BPMM and other forms of micro-mobility. When examining practical impacts, BPMM was found to increase commuting efficiency and maximize land use, but concerns are raised towards safety and seasonality. In terms of health, BPMM is found to have direct and indirect positive influences on both physical and mental health. Social impacts highlight how micro-mobility can increase access to health care for various marginalized communities. When deciding to use BPMM, financial impacts related to owning and maintain a BPMM should be considered, albeit they are still lower than owning a car.

The evidence provided in this report shows BPMM to be a viable mode of alternative transportation that has the potential to be accessible to a large percentage of the population given additional support by municipal/city, provincial and federal governments in the form of infrastructure development, funding, rebates and incentives. The implementation of additional infrastructure by cities such as bike-lanes, secure storage etc. would further the growth of BPMM usage and result in benefits to the environmental, individual and economic health of our communities. The support of BPMM by large institutions, such as schools, hospitals and other health care facilities, in the form of infrastructure implementation (e.g., secure storage, chargers) and awareness raising initiatives would also result in increased usage of BPMM and bring direct and indirect benefits to the institution, the surrounding community, and to the nation at large.

Recognizing that the transportation of staff, patient, goods and services make up a significant portion of the emissions from the health care sector, BPMM usage and promotion should be considered essential to the transition to clean transportation. As outlined in this report, there are numerous direct and indirect benefits to the health and wellbeing of using BPMMs. There is an opportunity for the Canadian health sector to show community leadership by adapting these new practices that will improve planetary health.

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