Can E-scooters Enhance Active-Mobility Health Outcomes?

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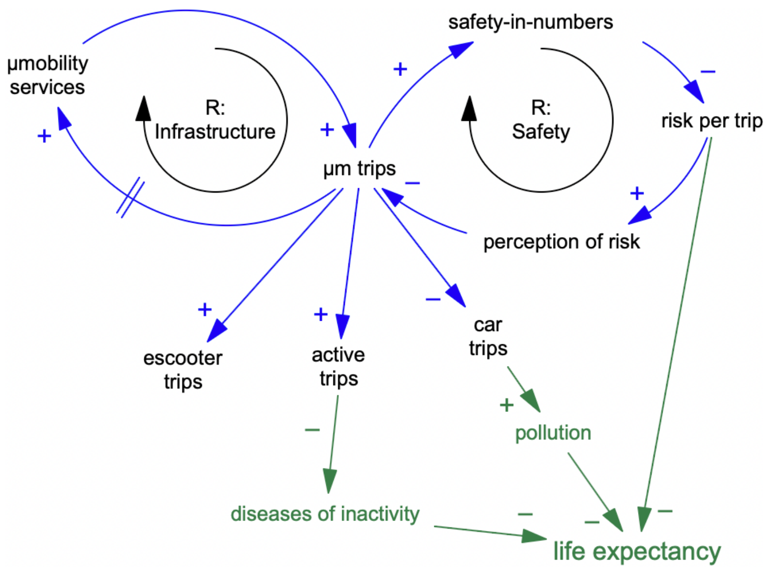
Background: Micromobility (μmobility) can improve wellbeing through numerous mechanisms including mobility equity, pollution reduction, urban space reclamation, empowerment, childhood cognitive development, resilience, and sustainability. Active μmobility—most commonly bicycling and walking—additionally improves healthy life expectancy due to increased physical activity. Passive μmobility modes such as e-scooters lack the exercise benefit of active modes, negating a primary public health benefit.

We postulate that due to similar size, speed, and capabilities, e-scooters trigger safety and infrastructure feedback loops that can also benefit bicycling and walking. If this holds, then e-scooters could accelerate a transition to a healthier urban environment.

We explore the circumstances in which e-scooters have the greatest potential to improve urban mobility and health, and call attention to areas in which their introduction may be more likely to have a negative impact.

Methods: We connect various threads of mobility and health research, yielding a dynamic model. We consider interactions between four transportation modes: bicycles, walking, e-scooters, and cars. We sketch causal loops that link μmobility modeshare to safety-in-numbers, infrastructure development, and, ultimately, life expectancy, estimated as a sum of contributions from exercise, deadly crashes, and air pollution.



We model two structural factors contributing to mode choice, each of which forms a reinforcing feedback loop with the popularity of μmobility:

Safety-In-Numbers: More biking $\leftrightarrows$ Safer biking

- Collisions $\propto (\Delta x)^\beta$, risk $\propto \frac{(\Delta x)^\beta}{\Delta x} = (\Delta x)^{\beta-1}$, $\beta \approx [0.25 \ldots 0.4]$
  - e.g. when μmobility use doubles, collision risk decreases by $\sim$35%
- Mode choice is based on perceived risk. We assume that this varies proportionally with true death risk but is sufficiently amplified (e.g. by close calls) to yield the observed modeshare.

Infrastructure availability: More μmobility $\leftrightarrows$ More μmobility-friendly routes, destinations, facilities, policies. . .

We model three contributors to life expectancy:

Physical activity: Bike commuting at typical intensity for ∼150–300 minutes/week reduces all-causes mortality by ∼35%. Roughly, an hour of bike commuting increases life expectancy by ∼2–3 hours. Walking is somewhat less effective exercise due to typically lower exertion.

Fatal crashes: In Europe, 1–2 cyclists are killed per 10^8 km ridden. North America is 3–6 times more deadly. Non-fatal crashes can be devastating, but we ignore them due to less certain data.

Pollution: We treat the dose-response relationship as linear, and the dose as linear in the number of car trips.

When do e-scooters outcompete the other modes? From the literature:

- Bicycles: around 10% of trips.
- Walking: 30–60% of trips.
- Cars: highly variable; we assume that competition is based on relative utility and speed.

Because e-scooter speed limits are often enforced through software, we use this as an extrinsic policy tool through which to modulate e-scooter attractiveness relative to cars, bicycles, and walking.

Results: While e-scooter speed limits are expected to have some effect on life expectancy by controlling the crash fatality rate, a far more powerful effect is achieved when speed limits are instead used to shape μmobility demand, which can drive wide-ranging public health and wellbeing outcomes through multiple reinforcing feedback loops. Furthermore, the safety-numbers and infrastructure feedbacks amplify each other, suggesting value in co-optimising these amplifiers. We find that e-scooters are most likely to improve public health through the estimated metrics in the following situations:

Polluted cities: If e-scooters effectively compete against cars, then the pollution-reduction effect can outweigh the exercise-reduction effect. This is a likely outcome in large cities in developing countries, but is difficult to achieve when car pollution levels are more typical of most cities in developed nations.

Infrastructure improvement rate: Supporting infrastructure powerfully encourages increased μmobility. If investment in infrastructure responds only slowly to increased demand, then the primary driver of increased μmobility is S-I-N—at least the (short-timescale) component of S-I-N related to driver awareness, rather than the (slower) component due to safety infrastructure. If e-scooters activate the S-I-N feedback as suggested, then they increase the appeal of all modes—including active ones—despite slow infrastructure development.

Car speed: Cities with higher average car speeds are likely to benefit more from (faster) e-scooters than cities in which active modes are relatively more competitive.

Traffic congestion: As μmobility reduces car trips, car traffic congestion is reduced, and a rebound effect is observed. In general, e-scooters appear to have the greatest positive contribution when the freeflow traffic speed is high and rush-hour traffic slows to speeds similar to the e-scooter limit.

Bike-scooter conflicts: If e-scooters reduce active modes—either by reducing the perception of safety or by tempting cyclists and pedestrians to switch to e-scooters—then the regions of state- and policy-space in which scooters facilitate public health are much smaller, showing net benefit only in the most polluted cities. This strongly indicates that every effort should be made to ensure that e-scooters do not deter active modes. This especially applies to new / inexperienced / young / old / vulnerable users—who constitute most of the potential flow into the stock of habitual cyclists. These potential users have an outsized impact to population health due to the nonlinear exercise-health dose-response curve, and may also make an outsized contribution to measures of mobility equity, childhood cognitive development, parental de-burdening, etc...

This exploratory research is not meant to be predictive, but rather to encourage further study of potential system behaviours and their effects on public health, and to stimulate conversation about possible synergies and conflicts.

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