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E-BIKES
Expanding the practice of cycling?

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Defining e-bikes

Electrically-assisted bicycles (or e-bikes) are bicycles combining muscular power with an electric assistance which activates when pedaling. E-bikes are enjoying an increasing commercial success. Whilst this success is also part of a larger trend of the rebirth of cycling, the development of e-bikes has been more rapid than the uptake in conventional cycling in many countries. E-bikes have been most successful in traditionally high-cycling countries like the Netherlands and Belgium, where they are overtaking the sales of conventional bicycles for adults (Forbes 2019).

Two main categories exist: e-bikes limited to an assistance of 25 km/h (or 20 mph/32 km/h in the United States and Canada) ("pedelecs"); and those with an assistance up to 45 km/h ("speed-pedelecs" or "s-pedelecs"). Pedelecs account for the bulk of e-bike sales and are considered legally equivalent to conventional bicycles. In most countries, speed-pedelecs are restricted to on-road use and forbidden from using bicycle paths, a legal status which has hampered their development. Indeed, the only countries to our knowledge where they are allowed on cycle paths are Switzerland and Belgium, where the highest shares of speed-pedelecs are found (15% and 4% of e-bike sales, compared to 0.9% in the Netherlands, and 0.5% in Germany). E-bikes also increasingly include recreational bicycles (for mountain biking and road cycling) and various kinds of cargo-bikes to carry goods or children.

E-bikes possess a hybrid status between strictly muscle-powered bicycles and motorized two-wheelers, combining the advantages of both. Pedaling makes for exercise and the electric assistance multiplies the rider's abilities, especially in some circumstances (going uphill, against the wind, carrying heavy loads, etc.). However, some vehicles labeled as "electric bicycles" do not require pedaling and are controlled by a throttle (Behrendt 2018; Rose 2012). They are especially popular in China (Weinert et al. 2007), where an e-bike boom at the end of the 1990s was called a "policy accident" because it resulted from a ban on gasoline-powered two-wheelers (Yang 2010). Currently, there are about 300 million electric bikes on China's roads (Bloomberg 2021), with the country being the world's foremost producer and market for electric two-wheelers. This kind of "no-pedaling" e-bike falls outside the definition adopted in this chapter.

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In comparison to conventional bicycles, e-bikes travel faster and make it easier to cover longer distances (Cairns et al. 2017; Jones, Harms et al. 2016), reduce the barrier of topography (Lopez et al. 2017; MacArthur et al. 2014) and facilitate carrying loads or children. They also accelerate more rapidly and maintain higher speeds while requiring less physical exertion (Popovich et al. 2014). Because of their 'combination of leg and battery power' (Behrendt 2018: 64), e-bikes play an 'intermediator role' (Wolf & Seebauer 2014) or that of a 'transitional step' (Popovich et al. 2014) between conventional bikes and cars. By reducing the effort needed to cycle, e-bikes broaden the appeal of cycling to a larger spectrum of users and, due to their increased range, substitute trips made by motorized modes.

This chapter traces the history of the e-bike before giving an overview of the literature on e-bikes. It then draws on research projects the authors carried out in Switzerland to highlight how e-bikes contribute to extend the practice of cycling in terms of population groups and spatial contexts. The conclusion identifies some key questions for research and policy.

Historical perspective

Bicycles with an electric or gasoline-powered motor have existed since the start of the 20th century. Indeed, soon after the invention of the modern safety bicycle, motorized versions were developed. The Simplex, a bicycle equipped with an electric motor and battery, was for example produced in the 1920s in the Netherlands (spinningmagnets 2013). In the 1950s, as motorcycles became heavier and more powerful, cheaper and lighter vehicles which had both pedals and a motor – *Mopeds* – including the French *Velosolex* (a bicycle with a gasoline-powered motor driving the front wheel), became popular, especially among the youth. However, in contrast to today's e-bikes, they required pedaling only to start up or going uphill.

Much later, in the early 1990s, the first bicycles with an electric assistance delivered while pedaling were invented. The first mass-produced modern e-bike was the Yamaha Pedal-Assist System in 1993 which was marketed to older people. Yet it took another 10 years for sales of e-bikes to start booming, as technological improvements in battery technology, from lead-acid batteries to lithium-ion cells, enabled a reduction in weight and increased safety and performance.

Since the 2010s e-bikes have grown into a major market. Between 2014 and 2019, the number of e-bikes sold annually in Europe grew from 1.1 to 3.4 million (+150%) (CONEBI 2020). E-bikes are by far the best-selling electric vehicles. The highest market penetration rates are in the Netherlands (24 e-bikes sold annually per 1000 inhabitants), followed by Belgium (22), Germany, Switzerland, and Austria (16) (see Table 24.1). These countries also have the highest proportions of e-bikes among new bicycle sales (the Netherlands, 42%; Switzerland, 37%; Belgium, 33%; Austria, 33%; Germany, 32%).

E-cycling: main findings of the literature

Research on e-bikes addresses four main questions: Which profile do e-bike users have? What are their motivations, barriers, and experiences? How much potential do e-bikes hold for substituting other travel modes? Which impacts do e-bikes have in terms of health and environment?

Electric assistance has opened cycling to a larger base. One trait of e-bike users is their higher age compared to conventional cyclists. Users between 50 and 65 years old are over-represented (Johnson & Rose 2013; MacArthur et al. 2014; Simsekoglu & Klöckner 2019; de Kruijf et al. 2019), while some studies report a majority of retired people (Wolf & Seebauer 2014).

Table 24.1 E-bike sales per country (in thousands of units), 2014 to 2019

Sales (in 1000s of units)	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*% change 2014–2019*
Total (Europe)	1140	1358	1667	N/A	2772	3397	150
Germany	480	535	605	N/A	980	1360	154
Netherlands	223	276	273	N/A	409	423	53
France	78	102	134	N/A	338	388	280
Belgium	130	141	168	N/A	259	251	78
Italy	51	56	124	N/A	173	195	248
Austria	50	77	87	N/A	150	143	86
Spain	18	25	40	N/A	110	143	472
UK	50	40	75	N/A	61	101	153
Switzerland	58	66	76	88	112	133	102

Source: Switzerland: Velosuisse; other countries: CONEBI, retrieved through https://bovagrai.info

The first buyers of e-bikes were older individuals, before spreading to younger cohorts, contrary to the stereotype of early adopters of an innovation being young (Peine et al. 2017). Young adults under 25 remain under-represented, due to the e-bikes' price and image (related to older users) and their stronger physical condition.

In terms of gender, e-bike users tend to follow the patterns of conventional cyclists. In cycle-friendly countries like Denmark and the Netherlands, where women are a majority among cyclists, they are over-represented (Haustein & Møller 2016), whereas a majority are men in countries such as the United States or Australia (Johnson & Rose 2013; MacArthur et al. 2014), where fewer people cycle. E-bike users live in households mostly composed of families or couples, with income and education levels above average (Johnson & Rose 2013; MacArthur et al. 2014; Wolf & Seebauer 2014).

The motivations for and barriers to e-cycling are similar to those found for conventional cycling (Haustein & Møller 2016). However, there are some differences related to electric assistance, such as the possibility to cycle despite steep gradients or long distances without sweating or feeling tired, even for people with a lower level of fitness (Dill & Rose 2012; Haustein & Møller 2016; MacArthur et al. 2014; Popovich et al. 2014). It may also be easier to complete a succession of journeys (activity chain) and to escort children with a trailer or a child seat (Jones, Harms, et al. 2016). For couples, the e-bike may present a way of working out and cycling together, as it "equalizes" differences of physical condition (Popovich et al. 2014). Improving one's health may be a motivation for e-cycling as well, because, despite electric assistance, it provides moderate-intensity physical activity and generates health benefits (Bourne et al. 2018).

However, some characteristics of e-bikes may be perceived negatively. As they are more expensive, their owners may be more concerned about theft and the need for safe storage. This may explain low e-bike ownership in cities in comparison to suburban and rural areas where housing (e.g. detached houses) may provide more adequate storage space (Ravalet et al. 2018). E-bikes are also heavier and more difficult to handle, and their weight may exacerbate 'range anxiety', which is the fear that the battery has an insufficient range to reach the destination (Popovich et al. 2014).

Another aspect is safety, with rising numbers of accidents following increases in sales (Schepers et al. 2014). The question remains open as to whether e-bikers are intrinsically more prone to accidents than conventional cyclists. Accidents may be linked to e-bikes' characteristics (higher weight and speed, more frequent use), but also to the riders (older, lower experience) or to motorists who underestimate e-bikers' speed (Petzoldt et al. 2017). Not much attention has been given to perceived safety but some accounts suggest that e-bike users feel more confident due to the ability to keep up with the flow of motor traffic and accelerate quickly from a stop (Jones, Harms, et al. 2016; Popovich et al. 2014; Rose 2012).

E-bikes have the potential for a modal shift by allowing for longer trips than conventional bicycles, though estimates of average trip distance vary from 3 to 11.5 km between studies (Bourne et al. 2020). Switching to an e-bike mostly affects either car use or conventional cycling depending on the dominant forms of mobility in the setting of the study (Sun et al. 2020). In car-centered contexts like North America or Australia, the e-bike is considered as a way to reduce car use (Johnson & Rose 2013; MacArthur et al. 2014), though this result has also been found in Sweden (Hiselius & Svensson 2017). Conversely, the e-bike mostly substitutes conventional cycling in countries where the population is already cycling at a high rate, such as in Denmark (Haustein & Møller 2016) or the Netherlands (Kroesen 2017). In China, where public transport is dominant, a modal shift has been observed from public transport to the e-bike (Cherry et al. 2016).

Although a shift from car use is more beneficial in environmental terms than one from conventional cycling (Rose 2012), both are positive as studies show an increase in the volume and duration of trips with e-bikes compared to conventional bicycles (Fyhri & Fearnley 2015). Furthermore, as we will discuss below, the e-bike allows some people to continue cycling (despite changes such as a new residential location, carrying a child, ageing, etc.) and to avoid shifting to motorized modes of transport.

Despite the electric assistance, e-bikes manage to provide a meaningful amount of physical activity (Bourne et al. 2018), especially when compared to non-active modes. Crucially, they contribute to better health for ageing users (Johnson & Rose 2015; Van Cauwenberg et al. 2019) as they improve cognitive functions and mental health through engagement with the outdoor environment, greater independence and mobility (Jones, Chatterjee, et al. 2016; Leyland et al. 2019). Health benefits concern all population groups as e-bikes are a way to incorporate physical activity in increasingly sedentary lifestyles (Gojanovic et al. 2011). Even when taking into account exposure to accidents and air pollution, the benefits of e-cycling for public health remain overwhelmingly positive (Götschi et al. 2016).

In terms of environmental impact, e-bikes consume energy through their electric assistance, but roughly half of the energy comes from the cyclist. Moreover, due to a low weight of around 20–30 kilograms, e-bikes are much lighter than most other vehicles. This translates to an overall energy consumption of around 1 kWh per 100 kilometers, which varies depending on gearing, assistance level, and hilliness. An electric car consumes 10–33 times as much energy to travel the same distance, depending on the model and its weight (Weiss et al. 2020). While the question of how lithium-ion batteries are produced and recycled is important, the amount of materials used in an e-bike is very limited in comparison to electric cars. A comparison of the lifecycle of different transport modes shows the e-bike's low ecological footprint is only beaten by the mechanical bike (or slightly by train in the case of Switzerland) (International Transport Forum 2020; OFEV 2018). This highlights the importance of the e-bike in the transition towards a low-carbon mobility.

E-cycling: expanding the practice of cycling?

In this section, we present two research projects in Switzerland to highlight how the e-bike may expand the social groups and spaces of cycling, and extend cycling over the life course. In Switzerland, 7% of all journeys are made by bike. This is higher than in most English-speaking and Latin countries and lower than in Northern Europe. As seen above, e-bikes represent more than a third of new bike sales, which makes Switzerland an interesting case study.

The first study was carried out among participants in the *Bike to Work* campaign who commit to cycling to work as much as possible in May and/or June (Rérat 2021a, 2021b). Among respondents, 10,833 (83.5%) are conventional cyclists and 2,141 e-bikers (16.5%). Folding bike and bike-sharing users (147) were removed from the sample. The e-bike widens participation in cycling across social groups: women (49% among e-bikers, 41% among conventional cyclists), people over 40 (76% vs 57%), and parents (56% vs 44%). It also shows a diversification of e-bikers in terms of gender and age. Although under-represented, younger cyclists rely on the e-bike to cover longer distances and to transport children.

The e-bike makes it possible to overcome some barriers faced by conventional cyclists, such as gradient, physical effort and distance (half of the users of a conventional bike spend 30 minutes or less on their commute both ways, compared to only one-third of e-bikers). It also expands cycling across space: People living in suburban and rural areas are much more present among e-bikers (53% and 23%) than among mechanical cyclists (43% and 14%), while the opposite is found among urban dwellers (23% vs 43%).

E-bikes reach groups that use motor transport more than average, expanding the practice of cycling as a complement or alternative to automobility. While the current cycling renaissance is mainly observed in cities, it has the potential to reach other spaces. However, both e-cycling and conventional cycling face similar challenges in terms of a lack of dedicated infrastructures and safety.

The second study (Marincek et al. 2020; Marincek & Rérat 2020) is based on 24 biographical interviews with e-bike users living in Lausanne, Switzerland. Participants had varied profiles and backgrounds in cycling, and had received a subsidy for an e-bike. The goal was to understand their cycling trajectories or "thoughts, feelings, capabilities, and actions related to cycling" over the life course (Chatterjee et al. 2012, p. 83). Adoption of the e-bike followed two main trajectories.

Restorative trajectories accounted for 14 users (58%). They had interrupted cycling by at least one year, sometimes much longer, most often in favor of the car. The e-bike enabled them to restore a regular cycling practice (Figure 24.1). Some were "returning to cycling" as they had already cycled regularly for transport before. Physical activity provided their main motivation, with e-bikes enabling an acceptable level of effort. A second group were "starting to cycle for transport". They adopted e-cycling as an efficient transport compared to car use. A third group used the e-bike as a means of "reinforcing a return to cycling" that they started with a conventional bike.

Resilient trajectories referred to 10 users (42%) who were already cycling regularly (Figure 24.2). As many chose not to own a car, cycling was their main mode of transport. The electric assistance served as a way of continuing cycling despite changes in their residential location or personal life that could have led to the reduction or interruption of utility cycling. A first group "replaced conventional cycling with the e-bike" completely. The assistance helped them to continue cycling despite the hilly topography, the need to carry children, or the advance of age. A second group alternated conventional cycling and e-cycling. The e-bike was used for utilitarian trips and in winter, whereas the conventional bicycle was preferred for summer and sport.

Both cycling trajectories show that e-bikes attract people who (re)start cycling, but, crucially, also help cyclists to sustain their practice. Moreover, they extend cycling during ageing.

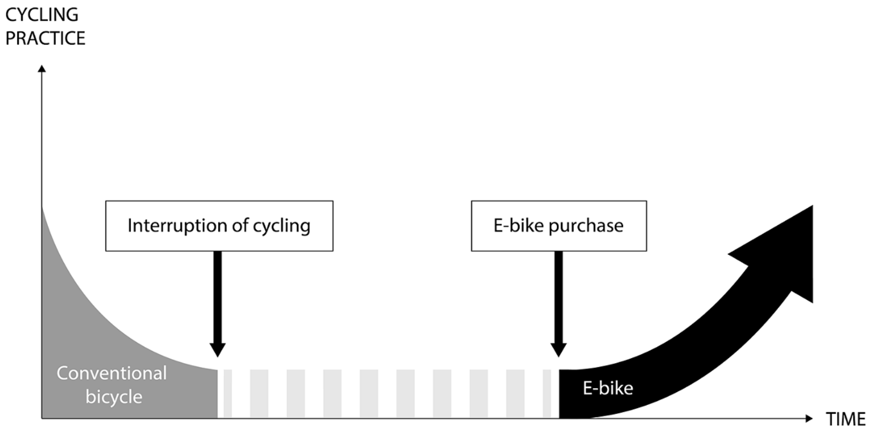

Figure 24.1 Restorative cycling trajectory. (Copyright Marincek & Rérat 2020).

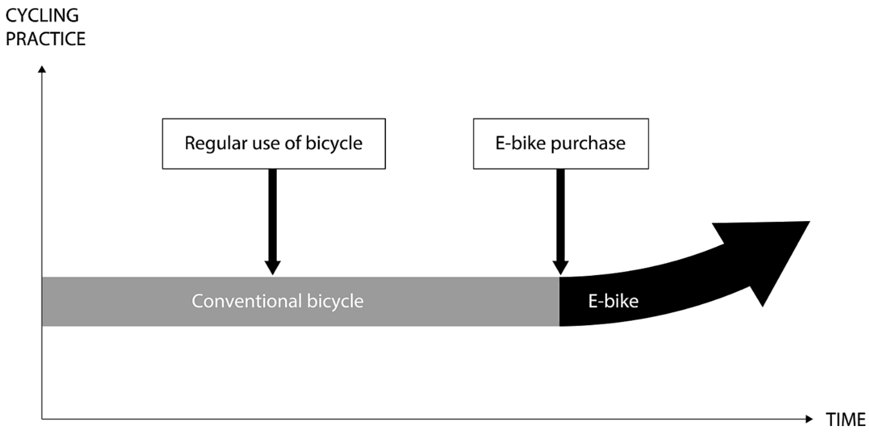

Figure 24.2 Resilient cycling trajectory. (Copyright Marincek & Rérat 2020).

Outlook: the future of (e-)cycling?

What does the future hold for cycling, and which place will e-cycling have in it? How will e-cycling evolve in years to come? Sales have been booming and have accelerated during the COVID-19 pandemic, with demand exceeding supply. What will be the effects of this trend? Will the diffusion of the e-bike within social groups and spatial contexts continue? Will e-cycling be considered not merely as a way to compensate for a lower physical condition, but also as an opportunity to cycle beyond what was previously thought possible? Will the e-cycling boom reach more rural spaces and countries outside the Global North and China? Will the current societal changes linked to the pandemic have lasting influences on travel practices, breaking routines, and inspiring users to experiment with something new, such as the e-bike? If so, how will such changes in mobility habits affect other modes of travel? The strong demand for cycling during the pandemic was linked to three phenomena: utility cycling to avoid crowding in public transport; sport cycling as traditional sport facilities are closed; and leisure cycling as international tourism has been halted. What will be the long-term effects on cycling?

A second series of questions relates to the way electric assistance changes the shapes and functions of bicycles and increases the potential of cycling. First, it increases the power, speed, and spatial range of bicycles. With advances in e-bike motors and batteries, how far can e-bikes be developed, and should legislation block or encourage these changes? Speed-pedelecs already push the boundaries of the performance of cycling, while alternative shapes such as electrically assisted velomobiles could rival cars or two-wheelers. Integrating e-bikes into bike-sharing systems may enlarge their catchment areas, foster intermodality with public transport and allow non-users to experience e-bikes. Second, electric assistance allows for larger bikes serving a wider array of uses and needs. Various forms of cargo bikes (front-loading, back-loading) strongly increase the carrying capacity of bikes used by families or businesses. Third, electric assistance is becoming more discreet and virtually invisible. Small motors and batteries can be fitted inside the frame, blurring the boundaries between existing categories of mechanical bikes and e-bikes.

Finally, the role and place of e-bikes depends on the politics of velomobility. Cycling as a practice requires infrastructures and regulations to make it safe, efficient, and enjoyable. During the pandemic, some cities have implemented pop-up bike lanes while others have expanded their networks to cope with increasing volumes of bicycle traffic. New cycling infrastructure does not go unchallenged as it implies a reallocation of space to the detriment of the dominant system of automobility. The rise of e-cycling forces planners to consider a greater diversity of bikes in terms of speed and size (as well as micromobility devices such as e-scooters), and creates new requirements for storage and maintenance services. In sum, e-cycling is set to play an increasing role in future sustainable velomobility.

References

Behrendt, F. (2018). Why cycling matters for electric mobility: Towards diverse, active and sustainable e-mobilities. *Mobilities*, *13*(1), 64–80.

Bloomberg. (2021, April 5). *E-Bikes Rule China's Urban Streets: Hyperdrive Daily*. https://www.bloomberg.com/news/newsletters/2021-04-05/hyperdrive-daily-e-bikes-rule-china-s-urban-streets

Bourne, J. E., Cooper, A. R., Kelly, P., Kinnear, F. J., England, C., Leary, S., & Page, A. (2020). The impact of e-cycling on travel behaviour: A scoping review. *Journal of Transport & Health*, *19*, 100910. https://doi.org/10.1016/j.jth.2020.100910

Bourne, J. E., Sauchelli, S., Perry, R., Page, A., Leary, S., England, C., & Cooper, A. R. (2018). Health benefits of electrically-assisted cycling: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *15*(1), 116. https://doi.org/10.1186/s12966-018-0751-8

Cairns, S., Behrendt, F., Raffo, D., Beaumont, C., & Kiefer, C. (2017). Electrically-assisted bikes: Potential impacts on travel behaviour. *Transportation Research Part A: Policy and Practice*, *103*, 327–342. https://doi.org/10.1016/j.tra.2017.03.007

Chatterjee, K., Sherwin, H., Jain, J., Christensen, J., & Marsh, S. (2012). Conceptual model to explain turning points in travel behavior: Application to bicycle use. *Transportation Research Record: Journal of the Transportation Research Board*, *2322*, 82–90.

Cherry, C. R., Yang, H., Jones, L. R., & He, M. (2016). Dynamics of electric bike ownership and use in Kunming, China. *Transport Policy*, *45*, 127–135. https://doi.org/10.1016/j.tranpol.2015.09.007

CONEBI. (2020). *2020 CONEBI Bicycle Industry & Market Profile*. CONEBI – Confederation of the European Bicycle Industry.

de Kruijf, J., Ettema, D., & Dijst, M. (2019). A longitudinal evaluation of satisfaction with e-cycling in daily commuting in the Netherlands. *Travel Behaviour and Society*, *16*, 192–200. https://doi.org/10.1016/j.tbs.2018.04.003

Dill, J., & Rose, G. (2012). Electric bikes and transportation policy: Insights from early adopters. *Transportation Research Record: Journal of the Transportation Research Board*, *2314*, 1–6.

Forbes. (2019). When will e-bike sales overtake sales of bicycles? For The Netherlands, that's now. *Forbes*. https://www.forbes.com/sites/carltonreid/2019/03/02/when-will-e-bike-sales-overtake-sales-of-bicycles-for-the-netherlands-thats-now/

Fyhri, A., & Fearnley, N. (2015). Effects of e-bikes on bicycle use and mode share. *Transportation Research Part D: Transport and Environment*, *36*, 45–52.

Gojanovic, B., Welker, J., Iglesias, K., Daucourt, C., & Gremion, G. (2011). Electric bicycles as a new active transportation modality to promote health. *Medicine & Science in Sports & Exercise*, *43*(11), 2204–2210.

Götschi, T., Garrard, J., & Giles-Corti, B. (2016). Cycling as a part of daily life: A review of health perspectives. *Transport Reviews*, *36*(1), 45–71. https://doi.org/10.1080/01441647.2015.1057877

Haustein, S., & Møller, M. (2016). Age and attitude: Changes in cycling patterns of different e-bike user segments. *International Journal of Sustainable Transportation*, *10*(9), 836–846.

Hiselius, L. W., & Svensson, Å. (2017). E-bike use in Sweden–CO_2 effects due to modal change and municipal promotion strategies. *Journal of Cleaner Production*, *141*, 818–824.

International Transport Forum. (2020). *Good to Go? Assessing the Environmental Performance of New Mobility*. https://www.itf-oecd.org/sites/default/files/docs/environmental-performance-new-mobility.pdf

Johnson, M., & Rose, G. (2015). Extending life on the bike: Electric bike use by older Australians. *Journal of Transport & Health*, *2*(2), 276–283.

Johnson, M., & Rose, G. (2013). Electric bikes–cycling in the New World City: An investigation of Australian electric bicycle owners and the decision making process for purchase. *Proceedings of the 2013 Australasian Transport Research Forum, 13*.

Jones, T., Chatterjee, K., Spinney, J., Street, E., Van Reekum, C., Spencer, B., Jones, H., Leyland, L. A., Mann, C., & Williams, S. (2016). *Cycle BOOM. Design for Lifelong Health and Wellbeing*. Oxford Brookes University, Oxford.

Jones, T., Harms, L., & Heinen, E. (2016). Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility. *Journal of Transport Geography*, *53*, 41–49.

Kroesen, M. (2017). To what extent do e-bikes substitute travel by other modes? Evidence from the Netherlands. *Transportation Research Part D: Transport and Environment*, *53*, 377–387.

Leyland, L.-A., Spencer, B., Beale, N., Jones, T., & van Reekum, C. M. (2019). The effect of cycling on cognitive function and well-being in older adults. *PLOS ONE*, *14*(2), e0211779. https://doi.org/10.1371/journal.pone.0211779

Lopez, A. J., Astegiano, P., Ochoa, D., Tampere, C., Beckx, C., & Gautama, S. (2017). Unveiling e-bike potential for commuting trips from GPS traces. *ISPRS International Journal of Geo-Information*, *6*(7), 190.

MacArthur, J., Dill, J., & Person, M. (2014). Electric bikes in North America: Results of an online survey. *Transportation Research Record: Journal of the Transportation Research Board*, *2468*, 123–130.

Marincek, D., Ravalet, E., & Rérat, P. (2020). The cycling trajectories of e-bike users: A biographical approach. In *Mobility Across the Life Course. A Dialogue between Qualitative and Quantitative Research Approaches* (pp. 221–241). Edward Elgar Publishing, Cheltenham, UK; Northampton, MA.

Marincek, D., & Rérat, P. (2020). From conventional to electrically-assisted cycling. A biographical approach to the adoption of the e-bike. *International Journal of Sustainable Transportation*. https://doi.org/10.1080/15568318.2020.1799119

OFEV [Swiss Federal Office for the Environment]. (2018). *Rapport sur l'environnement 2018*. Bern: OFEV.

Peine, A., van Cooten, V., & Neven, L. (2017). Rejuvenating design: Bikes, batteries, and older adopters in the diffusion of e-bikes. *Science, Technology, & Human Values*, *42*(3), 429–459.

Petzoldt, T., Schleinitz, K., Heilmann, S., & Gehlert, T. (2017). Traffic conflicts and their contextual factors when riding conventional vs. Electric bicycles. *Transportation Research Part F: Traffic Psychology and Behaviour*, *46, Part B*, 477–490. https://doi.org/10.1016/j.trf.2016.06.010

Popovich, N., Gordon, E., Shao, Z., Xing, Y., Wang, Y., & Handy, S. (2014). Experiences of electric bicycle users in the Sacramento, California area. *Travel Behaviour and Society*, *1*(2), 37–44. https://doi.org/10.1016/j.tbs.2013.10.006

Ravalet, E., Marincek, D., & Rérat, P. (2018). Les vélos à assistance électrique: Entre vélos conventionnels et deux-roues motorisés? [E-bikes: Between conventional bicycles and motorized two-wheelers?]. *Géo-Regards: Revue Neuchâteloise de Géographie*, *11–12*, 93–111.

Rérat, P. (2021a). *Cycling to Work: An Analysis of the Practice of Utility Cycling*. Springer Nature.

Rérat, P. (2021b). The rise of the e-bike: Towards an extension of the practice of cycling? *Mobilities*, *16*(3), 423–439.

Rose, G. (2012). E-bikes and urban transportation: Emerging issues and unresolved questions. *Transportation*, *39*(1), 81–96.

Schepers, P., Fishman, E., Den Hertog, P., Wolt, K. K., & Schwab, A. L. (2014). The safety of electrically assisted bicycles compared to classic bicycles. *Accident Analysis & Prevention*, *73*, 174–180.

Simsekoglu, Ö., & Klöckner, C. A. (2019). The role of psychological and socio-demographical factors for electric bike use in Norway. *International Journal of Sustainable Transportation*, *13*(5), 315–323.

spinningmagnets. (2013, November 9). Electric Bike History, patents from the 1800's. *ElectricBike.Com*. https://www.electricbike.com/e-bike-patents-from-the-1800s/

Sun, Q., Feng, T., Kemperman, A., & Spahn, A. (2020). Modal shift implications of e-bike use in the Netherlands: Moving towards sustainability? *Transportation Research Part D: Transport and Environment*, *78*, 102202. https://doi.org/10.1016/j.trd.2019.102202

Van Cauwenberg, J., De Bourdeaudhuij, I., Clarys, P., de Geus, B., & Deforche, B. (2019). E-bikes among older adults: Benefits, disadvantages, usage and crash characteristics. *Transportation*, *46*(6), 2151–2172.

Weinert, J., Ma, C., & Cherry, C. (2007). The transition to electric bikes in China: History and key reasons for rapid growth. *Transportation*, *34*(3), 301–318.

Weiss, M., Cloos, K. C., & Helmers, E. (2020). Energy efficiency trade-offs in small to large electric vehicles. *Environmental Sciences Europe*, *32*(1), 46. https://doi.org/10.1186/s12302-020-00307-8

Wolf, A., & Seebauer, S. (2014). Technology adoption of electric bicycles: A survey among early adopters. *Transportation Research Part A: Policy and Practice*, *69*, 196–211. https://doi.org/10.1016/j.tra.2014.08.007

Yang, C.-J. (2010). Launching strategy for electric vehicles: Lessons from China and Taiwan. *Technological Forecasting and Social Change*, 77(5), 831–834.