THINK Academy

3rd October, 2022
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E-cycling: opportunities for inclusion in active travel

THINK Academy Article 004

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This evidence summary explores the benefits of electric pedal assisted bicycles and tricycles (e-bikes/e-trikes) for public health and transportation comparing them against conventional bicycles. It considers opportunities to encourage their use in addition to conventional bicycles to enable cycling for more diverse user groups.

Suggested citation: Baker, L. Jones, S., Nicholass, A. Musselwhite, C. 2022. E-cycling: opportunities for inclusion in active travel. THINK Academy

Comparing the health benefits of e-bikes and e-trikes with those of conventional bikes

The benefits of regular cycling to public health are well known, such as the physical activity involved and its benefit to cardiovascular health, reduction in all-cause mortality, coronary heart disease mortality, cancer mortality and type-2 diabetes (Oja et al., 2011; Pucher et al., 2010; Rasmussen et al., 2016).

Cycling offers opportunities to enjoy the feeling of momentum, to be outdoors in nature or in social spaces, to be connected to others, and can reduce stress and anxiety with positive impacts on mental health and wellbeing (Garrard et al., 2012; Humphreys et al., 2013). The use of trikes and adapted cycles is also noted for improving and maintaining cardiovascular health, muscle tone and mental health among disabled people who find cycling easier than other activities (Inkle, 2020).

Overall, cycling using an e-bike is considered a moderate intensity exercise, less intense than using a conventional bicycle, although more so than walking and therefore e-bikes offer substantial physical health benefits (Bourne et al., 2018; Fishman & Cherry, 2016; Simons et al., 2009; Sundfør et al., 2020). Intensity of exercise depends also on individual use because the battery assistance can be adjusted and to some extent the topography of a chosen route (considering hills and inclines) (Langford et al., 2017).

While e-bikes generally require less exertion than conventional cycles, they also enable longer and more frequent journeys (Bourne et al., 2018; Castro et al., 2019; Fyhri & Fearnley, 2015; Sundfør et al., 2020; Van Cauwenberg et al., 2019). A study of seven European cities concludes that when users of conventional cycles switch to e-bikes, the additional distances they tend to travel each week counteracts lower exercise intensity (Castro et al., 2019). The study also finds a similar number of people are switching from car and public transport to e-bikes as are those switching from conventional bicycles and therefore, highlights the benefits of supporting e-bike use. E-cycling has also been found to improve cognitive function and wellbeing for older people (Leyland et al., 2019). It benefits riders' self-esteem, confidence in their capabilities and sense of achievement (Jones et al., 2022).

Enabling inclusion

E-bikes are enabling people to cycle who have experienced barriers using a conventional cycle. Their appeal is particularly useful for people whose ability, or lack of it, limits their confidence or capabilities to extend their exercise range including people new, or returning, to cycling (Langford et al., 2017). By adjusting an e-bike's battery power, users can control for an enjoyable (Wild & Woodward, 2019), or manageable exercise intensity, which is particularly useful for people with health conditions or disabilities (Bulthuis, 2022). Hilly terrain also becomes less of a barrier and people can access places they may have otherwise avoided (Jones et al., 2022).

E-bikes are enabling people to continue to cycle in their life course as they age, for longer than they might use a conventional cycle (Marincek & Rérat,

2021). The additional distance older people are willing to cycle using e-bikes means they can benefit from the ability to explore new places or revisit memorable ones (Jones et al., 2022). The extension of mobility provided by e-bikes increases feelings of self-efficacy and social connectedness (ibid.). E-bikes are not only used recreationally by older people but are also used to substitute car trips increasing opportunities for more utilitarian active travel among this age group (Johnson and Rose, 2015).

E-bikes are benefiting the confidence of female riders enabling them to challenge traditional gender norms, by cycling faster and further with confidence than when using a conventional cycle (Wild et al., 2021). The effect of e-bikes to increase people's cycle trip distances and frequencies is stronger among women than men indicating e-bikes could be particularly beneficial to women's health by extending their activity duration and range of mobility (Fyhri & Fearnley, 2015).

A study of e-cycling in later life finds that women have more tendency to use e-bikes for social purposes than men and so e-bikes could be particularly useful in maintaining women's social connections as they age because they generally have lower levels of car access than men in later life (Van Cauvenberg et al., 2019). Within the more traditional gender norms e-bikes are enabling women to undertake everyday responsibilities caring for children and others. Battery assistance enables load bearing opportunities, visible in the many e-cargo bike designs now available for carrying children and all the items that accompany them (Riggs & Schwartz 2018; Thomas, 2021; Wild et al., 2021).

Trikes and adapted bikes are used both as mobility and exercise aids to enable disabled people and those wanting a more balanced cycle to travel autonomously, improving self-confidence among users and opportunity to exercise (Clayton et al., 2017; Inkle, 2020; Verlinghieri et al., 2022).

Current research finds that e-trikes and adapted e-bikes offer a low-intensity form of exercise that can help people with a disability, chronic fatigue or joint pain to enjoy the benefits of cycling while controlling the level of power assistance and, therefore, exercise intensity (Bulthuis, 2022). The weight of trikes is a barrier to their use (Krausse et al., 2013) and battery assistance could improve the comfort of their use, but there is very little research on the use of e-trikes specifically for everyday mobility, health and recreation.

Barriers to e-cycling uptake and implications for policy

Actual and perceived safety risks are often cited as barriers to both conventional and e-cycling. Studies comparing incidents while using e-bikes against using conventional cycles have found there is generally no additional risk of collision or severity in injuries using e-bikes (Fyhri et al., 2019; Schepers et al., 2020). An exemption in these studies is female riders who are more likely than men to be inexperienced riders and are found to have less balance on the bike while riding and dismounting it (Fyhri et al., 2019; Schepers et al. 2020).

In terms of riders' safety perceptions people aged over 60 years and women tend to have a higher perception of safety risk using e-bikes (Houstein and Møller, 2016). However, this study and others note this is the same with or without battery assistance (Ryan et al., 2016; Houstein and Møller, 2016; Ravensbergen et al., 2019). Concerns among older people and women relate to interactions with other users of public space, including cyclists and pedestrians, as well as motorised traffic and relating to infrastructure quality (Houstein and Møller, 2016; Ryan et al., 2016). Women are also more concerned of the risk of personal attack and theft while cycling than men (Aldred et al., 2017; Ravensbergen et al., 2019).

European and UK legislation limits speeds of

unlicensed e-bikes to 25km/h and enforces motors assist (rather than take-over) pedalling. As the e-bike momentum increases, the motor's energy output is reduced, giving less assistance to pedalling. The additional acceleration speed of e-bikes comparative to conventional cycles enables faster movement from a stationary position. Many riders enjoy the comfort and fun of this (Popvich et al., 2014), while some also feel safer riding with motorised traffic (Bourne et al., 2020; Jones et al., 2016b). However, some e-bike users have perceived that other road users were unable to identify their cycle as battery assisted, which led to potentially dangerous situations (Haustein and Møller, 2016; Macarthur et al., 2018; Popvich et al., 2014). In these situations, e-cycle users thought that other road users were not always able to safely assess the time it would take to cross their line of travel without creating risk.

Provision of quality cycling infrastructure is a requirement to support e-biking in the same way it is required to support the use of conventional bikes and trikes. While e-bikes and e-trikes offer opportunities to increase cycling inclusion, many people experience difficulty accessing cycling infrastructure, for example, where barriers are placed deterring motor-vehicle use on off-road cycle ways, or because of stairs used to negotiate rail lines. Trikes and adapted bikes are often not recognised as mobility aids and when using them, people can experience hostility from other road and pavement users, a lack of suitable parking facilities, inability to board buses, steep cambers in roads, requests to dismount and walk, and a general lack of space for their presence in public (Clayton et al., 2017; Leger et al., 2019; Verlinghieri et al., 2022).

High-quality infrastructure that segregates riders from motor vehicles is beneficial to all users, particularly for under-represented groups and is necessary for increasing inclusion in active travel (Aldred et al., 2017; Leger et al., 2019). In order to support e-cycling, infrastructure needs to accommodate increased differences between cyclist's speeds making it safe and convenient for cyclists to overtake (Rérat, 2021). Infrastructure also will need to accommodate the additional size and turning radius of e-cargo bikes relevant to parking, cycle lanes and road intersections (Riggs & Schwartz, 2019). This also applies to adapted cycles and trikes including dropped curbs and the removal of physical barriers to enable accessibility (Gaffga and Hagemeister, 2016).

Confidence boosting exercises like ride accompaniment, formal training, or supervision during short distance trips away from traffic can encourage people to try out and use e-bikes safely (Jones et al., 2022). This is likely to particularly enable women's access to cycling since women are generally more often new or returning to cycling (Van Cauwenberg et al., 2019) and have lower cycling confidence, perceiving themselves more vulnerable to falls and collisions (Aldred et al., 2017; Ravensbergen et al., 2019).

When trying e-cargo bikes for the first-time people can benefit from training since the feel of riding and turning them is different to conventional cycles (Riggs & Schwartz, 2019). Appropriate safety equipment is advised to minimize risk (Bourne et al., 2018), for example, step through frames and correctly adjusted saddle height are suggested to reduce risks getting on and off e-bikes as with conventional bikes (Schepers et al., 2020).

Affordability of e-bikes prevents people from using them, particularly e-cargo and adapted cycles, which tend to be more expensive than standard bicycles (Andrews & Clement, 2021; Behrendt, 2017; Clayton et al., 2017; Melia and Bartel, 2021; Riggs & Schwartz, 2019; Wild et al., 2021). Improving accessibility of hire schemes that have a range of e-bikes, e-cargo bikes and trikes could help the inclusivity of e-bikes to support people's health and mobility (Thomas, 2022). Help-to-buy interest free loans or government assisted subsidies may also help to remove the affordability barrier and increase access to e-cycling and participation in active travel (Anderson and Hong, 2022; Sundfør and Fyhri, 2022). However, the accessibility of loan and subsidy schemes for people earning low-incomes, unemployed, on fixed-term employment contracts

(most affected by the affordability barrier) may be limited.

The additional cost of most e-bikes also makes theft a common barrier to people purchasing or loaning them (Handy and Fitch, 2020; Van Cauwenberg et al., 2019). E-bike users tend to be more concerned of theft while riding and leaving cycles parked or stored (ibid.). Bike theft impacts bike share schemes too through increased insurance costs and the challenge of sustainability with increased overhead costs and difficulties replacing stolen cycles with limited and delayed supply chains. Ensuring bike theft is being tackled by appropriate stakeholders is necessary in supporting use of e-bikes. Additional security is required at cycle storage and parking facilities, such as installing CCTV, using additional locked gated access, and placing cycle stands in secure locations.

The weight of e-bikes is cited as a disadvantage over conventional cycles (Jones et al., 2016 b; Melia and Bartel , 2021; Van Cauwenberg et al., 2019). This creates challenges getting e-bikes onto public transport, up steps or into buildings with stairs; an issue that impacts people differentially depending on their lifting capabilities (e.g. women, older people, people with health conditions and disabled people) and people living in flats related to the issue of lack of access to suitable storage space in residential areas (either publicly or privately owned) (Thomas, 2022).

Some users may be concerned with a lack of public parking areas offering shelter from the sun, rain, cold and in some cases seawater, which can reduce the life of batteries and connecting components. Bosch (2020), a common e-bike battery and motor manufacturer suggest batteries need to be stored at room temperature and in dry conditions, other than for short periods. Although batteries can be detached and taken home, or into the workplace, battery storage temperatures may need to be considered for e-bike sharing schemes accessible to multiple users. For example, cycles could be stored in a shipping container or locker, whereas batteries may need to be held somewhere warmer, or cooler depending on the season and context.

Evidence is inconclusive on whether, or not, the length of time a battery gives pedal assistance limits the use of e-bikes and perceptions are apparently mixed. Some users express no concern over batteries running flat mid-trip (Thomas, 2022) and conversely, others' express concern given the additional weight of e-bikes (Jones et al., 2016b;
Behrendt, 2017). A lack of publicly available charging infrastructure, therefore, may be a barrier for some (Bourne et al., 2020). Provision of charging for e-bikes could improve scope for their use including scope for longer-distance journeys.

Conclusions

With the ability to offer moderate levels of exercise intensity and to extend people's mobility, the time they spend exercising, their autonomy, and opportunities to be out in natural and social environments, e-bikes and e-trikes offer numerous health benefits. E- cycling also has potential to enable access to active travel by overcoming some of the barriers people experience related to their fitness, health, ability and/or confidence. E-bikes offer the opportunity to be in control of power-assistance and therefore, intensity of exercise which helps people with health conditions and disabilities to cycle and therefore experience the health benefits of it. Batteries help people to overcome steep inclines with confidence unlocking routes otherwise impossible to cycle, or improving the comfort and enjoyability of cycling. They afford the possibility of family oriented trips and have spurred the e-cargo bike market.

However, there are several barriers to overcome in improving the possibilities of e-cycling. Infrastructure for cycling needs to be designed and adapted for the increasing use of e-bikes taking into consideration a diversity of technologies and users aimed at improving safety and door-to-door experience. Secure, sheltered, over-night storage, parking and charging provision will be needed to suit the needs of various residential situations and different sizes of cycles.

Subsidies, grants, interest free loans are accessible hire schemes could help to improve the affordability and inclusivity of e-bikes, e-cargo bike, trikes and adapted bikes. Supportive social mechanisms that are educational and motivational would be particularly useful to introduce marginalised groups of people and novices to e-cycling. These services are mostly provided by charities and need greater financial support to develop more widely. With changes to the technologies people use to cycle, including battery assistance, adapted designs and load bearing designs, and with supply shortages and other cost of living and inflation rises, there is a need for local authorities, enforcement agencies and other stakeholders, to increase resources in counteracting bicycle theft and improving the security of public spaces.

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