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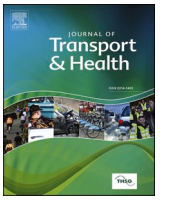

Challenging the inequities of ebike access: An investigation of a community-led intervention in a lower-income neighbourhood in Aotearoa - New Zealand

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ABSTRACT

Introduction: Ebiking offers positive physical and mental health benefits for riders. However, inequitable access to bike share schemes and purchase cost barriers limit ebike availability and uptake in lower-income communities. Furthermore, as bike culture differs from place to place, incentive schemes responsive to the local culture are needed to improve access to ebikes as a healthy mobility choice.
Methods: Three trials of ebike access were co-designed sequentially between 2021 and 2023. Give-it-a go, Ebikes in daily life, Pathway to Permanence were all designed by a community bike organisation working in tandem with a research team. Trial delivery was community-led. Trial participants' experiences of ebike use were gathered through group and individual interviews, and the research also included a brief before and after survey of trip destination and mode use.
Results: Trial participants valued their ebiking experience, including the skills training and group rides, new knowledge of safe routes, health benefits of exercise, and fuel savings. During the trial, a third of weekly trips were made by ebike, while trips made by motor vehicle reduced by 25%. Cost emerged as a substantial barrier to ebike ownership.
Conclusions: Effective models to support ebike uptake in lower-income communities will be characterised by: adequate funding of community organisations to grow local bike culture; safe and secure bike infrastructure; community ownership of an ebike fleet to support skill acquisition and social connection; and a pathway to low-cost ebike access.

1. Introduction

Biking offers positive physical and mental health benefits for riders (Wild and Woodward, 2019). In addition, it is affordable, efficient, and when widespread, can reduce traffic congestion and carbon emissions and improve air quality (Tortosa et al., 2021). However, the opportunities and constraints around biking are seldom equitable, with the transport choices available to urban residents determined by a mix of individual factors and neighbourhood social, cultural, locational and environmental characteristics (Braun et al., 2019; Shaw and Tiatia-Seath, 2022). Such inequities of transport choice are even more evident when considering ebike access and the associated costs. Nonetheless, biking can be a tool for transport equity (McCullough et al., 2019). In this paper, we test the

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appetite for using ebikes and ask how they could become an affordable option in an ethnically diverse, lower-income suburb in Aotearoa - New Zealand.

2. Background

The uptake of electrically assisted cycling – ebiking – is surging in Aotearoa - New Zealand, as elsewhere (Fishman and Cherry, 2016). The assistance of a battery-powered motor gives ebikes several advantages over traditional push bikes. They require less exertion and provide greater comfort, especially when carrying children or goods, riding on steeper terrain or travelling longer distances (Cherry and Fishman, 2021; Popovich et al., 2014; Wikstrøm and Böcker, 2020).

Although studies suggest physical activity benefits are lower for ebikes compared to push bikes, increases in trip frequency and length add to the physical activity benefits (Fishman and Cherry, 2016; Fyhri and Fearnley, 2015). An ebike can also make biking feasible for people who are older or have a health condition that limits their use of a traditional bike (Fishman and Cherry, 2016; Johnson and Rose, 2015). Further, they are experienced as 'fun' by riders, a frequent observation likely to sustain ebike use (Johnson and Rose, 2015; Popovich et al., 2014; Wild and Woodward, 2019).

The main downsides of ebike use are purchase price, maintenance costs (Abduljabbar et al., 2021; Bennett et al., 2022; Wikstrøm and Böcker, 2020) and concerns around battery range and complexity of use (Jones et al., 2016). The consequences of the cost barrier are a lack of visibility in lower-income areas and ownership and use rates that are positively associated with household income (Melia and Bartle, 2022).

Commercial ebike share schemes have proliferated in cities world-wide. However, while they could potentially increase access among lower-income groups (Dill et al., 2022; Yu et al., 2018), services tend to be concentrated in the urban core of cities and targeted to "those already physically able, willing and comfortable, given social norms, to navigate existing infrastructure" (Médard de Chardon, 2019, p. 401). By targeting younger, more affluent, and digitally literate inner-city users, ride share schemes increase inequities in transport choice, disadvantaging those living in poorer suburban neighbourhoods (Bauman et al., 2017; Caspi, 2023; Médard de Chardon, 2019; Soltani et al., 2022; Yu et al., 2018). As a result of the way bike share schemes are commonly configured, cost and use of credit card payment can become further barriers to use in these neighbourhoods (Dill et al., 2022). However, trials of discounted membership for low-income individuals and expansion of bike stations into lower-income neighbourhoods have been undertaken in several US cities to improve equity of access (Soto et al., 2021). While meagre equity benefits are reported by Soto et al. (2021) for the Boston example, the results of a modelling study by Yu et al. (2018) suggest it is a cost-effective intervention relative to other health programmes.

Bike cultures differ from place to place and between gender, class, and ethnic groups (Lusk et al., 2017). Consequently, developing an understanding of the local bike culture is crucial to designing effective interventions that recognise and respond to the nuances of practices and embedded meanings (Aldred and Jungnickel, 2014). Referring to Swidler, (1986) work on culture and practice, Aldred and Jungnickel suggest understanding local bike cultures can offer "a toolkit of resources enabling (or blocking) particular practices" (p. 79). Thorne et al., (2023) studied bike culture in two lower-income suburbs in Aotearoa - New Zealand. An ethnographic approach was applied to understand the 'human infrastructure' (Lugo, 2013) – the place-based, social networks and cultural practices that nurture and sustain active mobility. Although biking was not a common practice in these ethnically diverse communities with limited bike infrastructure, distinct examples of bike promotion and use were observed. Biking was predominantly a shared practice, carried out within a family or friendship group. Biking slowly in a group for leisure, through nature on off-road routes was favoured over moving quickly, alone, on direct routes as a commuter. Being part of a group was also a strategy for containing fears around personal security and traffic dangers. Community bike hubs, run by bike promoters attuned to local preferences, nurtured biking practices in these suburbs. The hubs offered the physical spaces and social and technical support needed to build skills and confidence among new and existing riders, including by hosting group rides, introducing riders to safe neighbourhood routes, and providing venues for all-ages promotional bike events. Family, food, and music, reflecting local cultural preferences, were usually integral to these events (Thorne et al., 2023).

Similar observations have been made in lower-income communities elsewhere, especially the preference for riding as a group (Dill et al., 2022; Lusk et al., 2017; Merchant, 2019). Bike share schemes have provided the context for a number of studies. Investigating bike share programme uptake among lower-income groups and people of colour in US cities, Dill et al. (2022) concluded that promoting bikes as fun, healthy and family-friendly was likely to encourage use. Compared to higher-income white people, the study found riding with others, with options for accommodating children, was more important in lower-income communities, and especially for people of colour. Reducing access costs, offering household and short-term or seasonal bike share membership, and cash-based payment options were also factors likely to increase uptake in these communities. Other studies in lower-income communities have reached similar conclusions (Caspi, 2023; Merchant, 2019). In addition, a community survey in the US by Lusk et al. (2017) found mountain bikes, wearing street clothes while riding, parking bikes inside homes, and riding in groups side-by-side on wide cycle tracks were all rated more highly by minority ethnic respondents compared to white respondents.

Local bike cultures both reflect and are sustained (or not) by the characteristics of place (Aldred and Jungnickel, 2014; Lugo, 2013). Furthermore, as with any transport mode, ebiking practice will be influenced by an 'assemblage' of factors. For example, in a 'driver-car' assemblage, different mobilities are drawn together in distinctive networks that require unique infrastructure, both soft (e.g., skills, knowledge, social relations etc.) and hard (e.g., material structures like roads, signs, cables, etc.) (Dant, 2004). These factors will become entangled in ways that shape the relations between different modes of travel (Shove, 2017), and can either combine to support, or collide to undermine specific practices (Edberg, 2023). This theoretical approach is useful to conceptualise an 'ebike assemblage' and the various attributes that influence ebiking experiences, taking into account the rider, the bike (and access to it), and the built and

socio-cultural environments of place (McCullough et al., 2019).

Cass and Faulconbridge (2016) argue transport modes cannot be analysed in isolation from the activities they enable, and ebiking offers wide scope in this regard. Recreational riding, commuting and other types of utility riding, such as shopping or dropping children to school, are all enabled by ebiking and may combine in complex mobility practices (Southerton, 2003). However, without adequate built or social infrastructure the linkage between these practices is more fragile or obstructed (Edberg, 2023).

Qualities of the socio-cultural environment are important to the experience of biking, and perceptions of safety – people and traffic-related – can be amongst the more critical place-based influences on biking practices (Thorne et al., 2023). Thorne et al., (2023) identified enduring challenges to safety in their study areas, particularly for women. Their research highlights the importance of investment in cycling infrastructure for sustaining active mobility practices, and also the need for riders to acquire competencies to face threats to personal safety.

A just and sustainable mobility transition (Ghosh et al., 2016) implies that all population groups can mode shift to less carbon-emitting practices. By replacing private car trips, bike (Cairns et al., 2017) and ebike trips (Philips et al., 2022) contribute to more sustainable urban mobility systems. However, given the high cost of ebikes, uptake is unlikely to be equitable unless incentive schemes to support their longer-term use target lower-income suburban communities (McQueen et al., 2019). A review of ebike incentive schemes in the US and Canada in 2022 identified 53 programmes, with income thresholds applying to a quarter of these (Bennett et al., 2022). Cash incentives, delivered as either post-purchase rebates or point-of-sale discounts, were by far the most common form of incentive.

A chance to trial an ebike and experience its utility is a promising strategy for encouraging future use (McQueen et al., 2019; Hawley et al., 2020). One effective way to provide short-term, free, or low-cost access is through an ebike library, where borrowers are typically offered a range of ebikes to trial for varying lengths of time. Ebike libraries are often also promoted as try-before-you-buy programmes. For example, libraries in Vermont in the US provide a pathway into ebike purchase incentive programmes (Local Motion, n.d.). Other ebike libraries are membership based, with ebikes borrowed for set durations. Systems differ from place to place, with some offering non-credit card payment methods to include people without a credit option (Janzer, 2022).

Aligning ebikes trials and access schemes with local needs, aspirations, and bike cultures is likely to increase programme engagement and the potential for ebike uptake. This in turn may generate a pathway for reducing inequities in transport choice, enabling the ebike to become a 'tool for social equity' (McCullough et al., 2019, p.11). MuCullough and colleagues (2019) argue that effective delivery of bike promotion programmes in lower-income communities requires funding bodies to embrace difference and identify and invest in community organisations and community-designed solutions. Their rationale for this position is that community organisations are embedded in the socio-cultural networks of place, and thus often hold the local knowledge and relationships necessary to foster the emergence of new mobility practices (Lugo, 2013; Thorne et al., 2023).

In this paper, we present a three-stage ebike trial to explore how to make ebikes an affordable option in Māngere, an ethnically diverse, lower-income suburb in Aotearoa - New Zealand. The trials were co-designed by community bike promoters and our research team, sponsored by a local community board and funded by regional and national transport agencies. First, we introduce Māngere and the trial partner, Triple Teez (TTT). This is followed by an account of the three trials, with their goals, methods, implementation, and outcomes described independently and sequentially. Finally, the overall findings are discussed, followed by reflection on lessons learnt from the trials for future ebike delivery options in Māngere, and other lower-income communities.

3. Study context: Māngere and Triple Teez

3.1. Māngere

Māngere is located in Auckland, a sprawling low-density city of 1.6 million people in Aotearoa - New Zealand. Car dependency is high and rates of active travel are low throughout the city. In 2018, 75% of commuting trips in Auckland were made by car and 5% by active mode, with corresponding figures of 84% and 2% reported for the Māngere Ōtahuhu local area (Knowledge Auckland, 2020). Transport-related health outcomes are poor in this predominantly Pacific and Māori community. As well as low rates of active travel, road traffic injuries have been amongst Auckland's highest (Hosking et al., 2013) and the diabetes rate (17.3%) is over twice the Aotearoa - New Zealand average (Warin et al., 2016).

Māngere was built as a dormitory suburb in the mid-20th Century and, as a result, its street design prioritises the movement of vehicular traffic over other forms of mobility. Improvements were made to walking and biking infrastructure in parts of Māngere between 2014 and 2017 as part of Te Ara Mua−Future Streets project. On and off-road footpaths were widened, streets landscaped, and traffic calming measures implemented, along with the construction of raised crossings and protected bike lanes on some collector and arterial roads (Mackie et al., 2018). Intermittent extensions or upgrades to active travel infrastructure continue, but the network remains incomplete and of variable quality.

Te Ara Mua−Future Streets intervention resulted in significant reductions in traffic speeds and volumes in residential streets in the intervention area relative to the control area (Thorne et al., 2023). However, thus far, levels of active travel have not generally increased. As Tortosa et al. (2021) observe in a paper entitled 'Infrastructure is not enough', soft interventions can complement infrastructure upgrades and play a crucial role in increasing opportunities for active travel in lower-income communities. Our community partners were eager to trial ebike access as a means of increasing opportunities for active travel.

3.2. Triple Teez (Time To Thrive to stay alive)

Triple Teez (TTT) is a community trust established in 2014 to promote biking in Māngere and led by local resident and bike champion 'Mr Tee', Teau Aiturau. TTT run a range of bike-focused, workshops and community events for people of all ages. They restore and distribute donated bikes, run bike sessions in schools, provide riding skills training and bike maintenance workshops, and host regular group rides. Funded by local government agencies, the TTT Māngere community bike hub was set up in a prime location adjacent to the Māngere Town Centre. Prior to partnering with the research team to co-design and deliver the ebike trials, TTT had used ebikes donated by a ride share company to run 'green prescriptions' courses for patients referred by a local medical centre.

The researchers posited that the Trust's knowledge, relationships and embeddedness within Māngere socio-cultural networks would be crucial to delivering an effective ebike trial and nurturing new mobility practices (Lugo, 2013; McCullough et al., 2019; Thorne et al., 2023). Not only were TTT instrumental in producing a local bike culture, they were also attuned to community concerns and the need to alleviate barriers to participation.

4. The Māngere ebike trials: methodology and findings

A three-stage trial process was initiated, with all trial stages co-designed by TTT and the research team and enabled through local and central government funding. The overall goal was to identify a model by which ebikes would be made routinely available to Māngere residents. By adopting a three-stage process, practical considerations and potential barriers to using, maintaining, and retaining ebikes could be identified and addressed in a stepwise fashion. It was envisaged that by focusing on successful ebike experiences and adoption, knowledge would accumulate iteratively. At the outset ebikes were uncommon on Māngere streets, so the first step was to increase their visibility and offer people the experience of riding an ebike.

Written consent was obtained from trial participants prior to data collection and research procedures were performed in compliance with relevant laws and institutional guidelines. Low risk ethics approvals were obtained from Massey University.

4.1. Trial 1: Give-it-a-go

In 2021, TTT delivered a *Give-it-a-go trial*. Using ebikes loaned by ride share companies and other donors, 18−20 people participated in three evening workshops during which they progressively gained skills and confidence riding on and off-road. The Give-it a go trial was an opportunity to increase the visibility of ebikes in Māngere and to test community interest in, and readiness to adopt ebikes as a form of mobility. The participants all had prior contact with TTT, rode a push bike and were invited to take part in the Give-it-a-go trial. During a follow-up focus group, participants shared their experiences of the trial and their interest in longer-term access to an ebike. For most participants it was a challenging but enjoyable experience and there was a desire for further opportunities to use an ebike, ideally for several weeks or months. The cost of an ebike, seen as equivalent to the cost of a cheap second-hand car, was considered a major barrier to ebike uptake in Māngere. Although participants could envisage using an ebike to replace some car trips to local destinations, a car would remain essential for other types of trips. A lack of riding confidence, the potential for injury to the rider and theft or damage to an ebike were flagged as concerns to be addressed in subsequent stages of the trial.

4.2. Trial 2: Ebikes in daily life

Buoyed by the success of the Give-it-a go trial, funding was sought for a second trial to explore the potential for integrating ebikes into daily travel patterns in Māngere. The *Ebikes in daily life trial* was funded by Nga Tiriti Ngangahau − Auckland Council Climate Fund. The funding enabled 22 ebikes, including two cargo ebikes, to be purchased for use by participants, as well as a range of bike

Figure 1. Ebike branding.

accessories, including: helmets, panniers, locks, and bike covers. Ebike specifications included models able to accommodate larger bodies. The ebike frames were branded with bold and colourful straplines such as 'Watts up, Māngere', 'Bike capital of the Pasifik' and 'Gone ebike Mād-gere' to clearly identify them as Māngere community ebikes (see Fig. 1).

The project funding supported TTT and the research team to develop a trial protocol, and then deliver and evaluate the trial. The trial administration and delivery roles carried out by TTT included participant recruitment, rider skills training, guided community rides, routine ebike maintenance, and providing trial participants with encouragement and support. An evaluation of the trial was undertaken by the research team.

Forty participants were recruited and provided with an ebike and accessories for trial periods of three months between November 2022 and June 2023. The criteria for participation were: being aged 18 years and over, residing or working in Māngere, having secure storage for the ebike at home, and not being a regular ebike user. To allay TTT's fear of the ebikes being damaged or stolen, home storage facilities were vetted via a site visit or review of photographs of storage provisions. Two waves of recruitment took place. The first involved Māngere residents with a prior association with TTT, and the second wave targeted people working in Māngere, with recruitment taking place through workplaces and community organisations (an airline, school, marae – indigenous community facility, and a health centre).

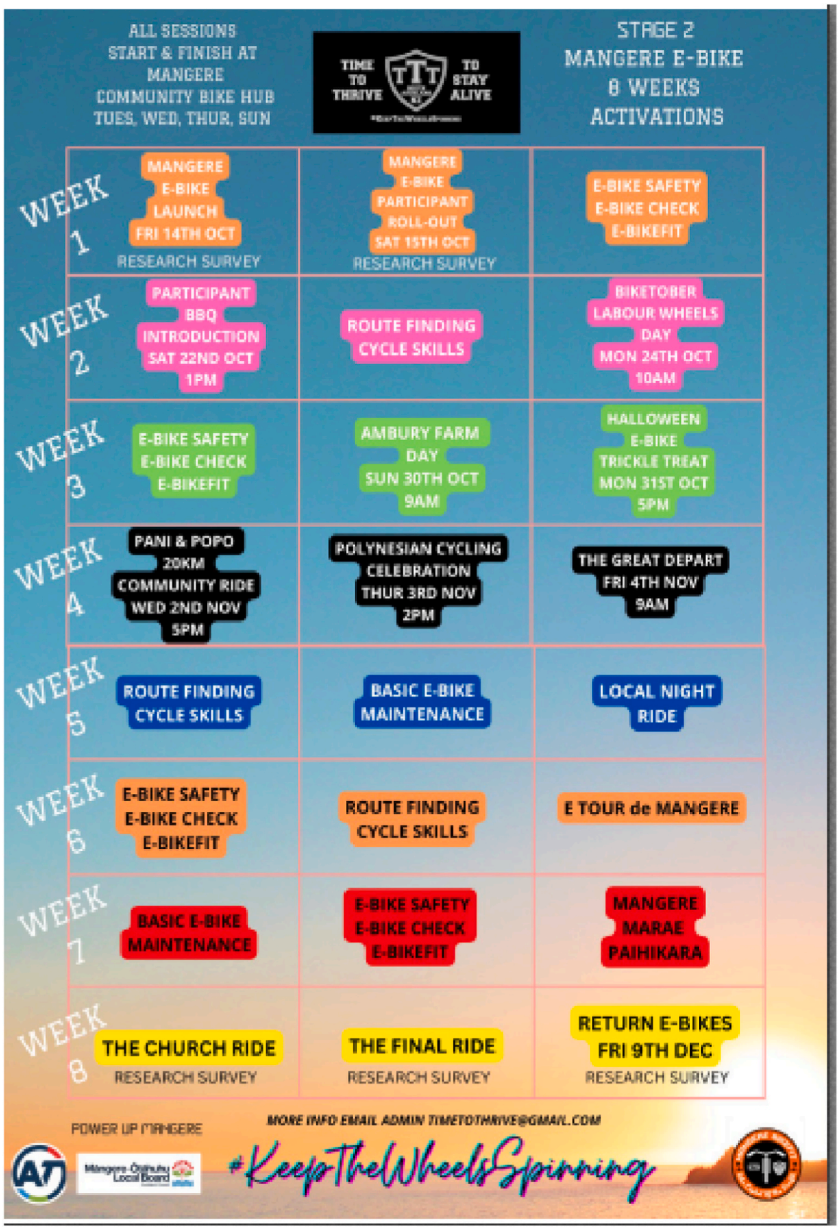

Figure 2. A schedule of weekly guided rides.

In keeping with the socio-cultural practices of the bike hub and wider Māngere community, a blessing ceremony for the ebikes was held, supported by an elder from Te Akitai Waiohua, the indigenous tribe with authority over the Māngere area. A formal event was also held to launch the trial, after which the first wave of participants signed on. This trial involved instruction on riding, storing, securing, and maintaining the ebike, agreeing to obey the road code and adhere to bike care and maintenance requirements, consenting to take part in the evaluation, and completing baseline and follow up data collection. Riding skills were assessed and the ebikes and accessories distributed. Throughout the trial period TTT led weekly guided group rides designed to increase participants' riding confidence, show them safe routes and secure bike parking within and beyond Māngere, and to have fun (see Fig. 2). Sharing food at the end was an important aspect of the ride. Weekly check-in sessions were also held at the bike hub for participants to seek advice and have their ebikes checked.

4.2.1. Data collection

Four types of data were recorded:

A brief baseline survey recorded demographic information, as well as existing push bike ownership and frequency of use, and number of trips made by different travel modes to a range of destinations (e.g., work, study, recreation, family, shopping) over the previous seven days. The data on trips by mode to destinations were also collected for the final week of the trial. The total number of trips to destinations reported pre and post the trial were aggregated and the percentage of trips by different modes were calculated for the two time periods.

Odometer readings were recorded at the outset and termination of participants' ebike trial period and the total kilometres travelled by each participant was calculated.

After the trial period, participants were interviewed face-to-face or by telephone to explore how the ebikes were used, positive and negative experiences of having the ebike, as well as their interest in, and barriers to further use of an ebike.

Two key TTT staff were interviewed to explore their experiences of delivering the ebike trial.

4.3. Trial 2: Participant findings

Findings from the brief surveys conducted with participants before and after the trial are presented in this section, followed by a summary of a thematic analysis of interview data on participants' experiences of the trial.

Female participants made up 56% of the trial group, and males 44%. Participant ages ranged from 27 to 69 years, with two-thirds aged between 40 and 60 years. Consistent with the ethnic composition in Māngere, Samoan and Māori were the main ethnic groups represented, with small numbers of other Pacific groups, Indian, European and African people. Almost half the participants reported having ridden a pushbike 'a few times' in the previous 12 months, while three had never ridden a push bike and three had been daily riders.

Fig. 3 shows a comparison of the proportion of trips to all destinations (in the week before the trial and the final week of the trial) made by motor vehicle, bike (push bike or ebike), and other modes (e.g., walking or public transport). The combined results from participants who completed both travel surveys show that over a third (33%) of weekly trips were made by bike during the trial, and trips made by motor vehicle reduced by 25%. Reliable before and after survey data were available for 22 participants. Missing data were primarily due to difficulty contacting participants at the end of the trial, which resulted in missing or delayed data collection.

The post-trial surveys showed no consistent patterns in participants' mode shift behaviours. Several participants had continued to make all trips to destinations reported in the pre-trial survey, by car, and ebike trips were made to only new destinations, most commonly recreational sites. Conversely, another group of participants, most of whom used the ebike to commute to work, reported having substituted amost all previous car trips across destination types with ebike trips. Others reported partial trip substitutions. Kilometres travelled by participants over the trial period, retrieved from odometers, was similarly varied, and ranged from 36 km to 1,057 km, with a median of 299kms. Reliable data were available for 29 participants (Fig. 4). The missing data were due to a subset of the ebikes having odometers that were too easily, and mistakenly reset to zero and several bikes not having fitted odometers.

The participants who recorded higher kms used the ebikes daily for commuting or regular exercise, whereas those recording fewer

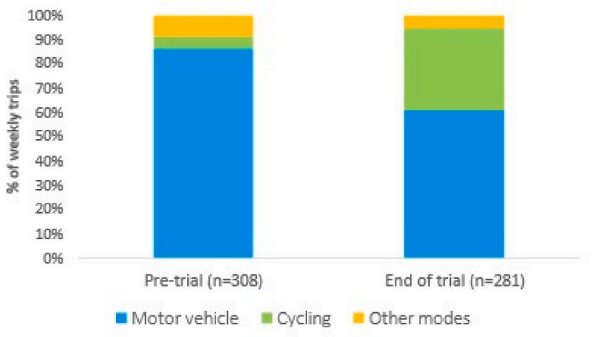

Figure 3. Weekly trips, by mode, pre- and end of trial. N values shown are total trips reported.

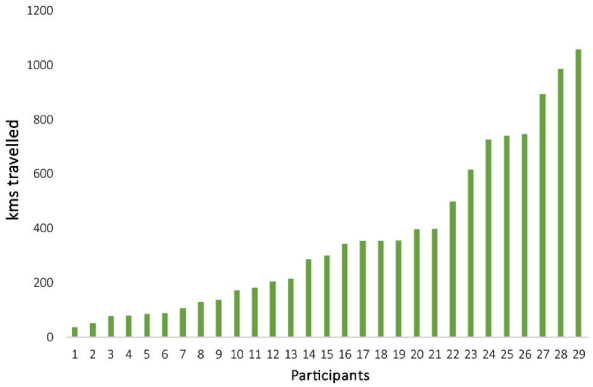

Figure 4. Odometer readings of kilometers travelled over trial period.

kms tended to use the ebike occasionally for a recreational ride. As many in the latter group had limited biking experience, a weekly or monthly recreational ride represented a significant step in their cycling journey.

Analyses of in-depth interviews indicated most participants enjoyed the ebike trial experience and wanted to continue riding, particularly if the ebike had become part of their daily travel routine and/or resulted in physical or mental health benefits. As one participant commented: *"I loved it … It's sort of woken up the body."*

For those who substituted car trips with ebike trips, a reduction in weekly fuel travel costs was an added benefit: *"Usually on the pay cycle, my petrol tank is dam near empty … Then we got the ebikes … when I got paid again … it had only gone down by half, because it had pretty much just sat in the driveway."*

Pre-trial biking experience varied amongst participants, and this influenced their ebike use during the trial. The experienced riders used the added power and speed to extend the distance and frequency of rides, while those with little to no experience often took between several weeks to a month or more to feel comfortable riding the ebike. The trial duration was extended to accommodate the latter group. TTT's support and the confidence gained on group rides were particularly important for these individuals, especially those for whom the group rides were their first experience of riding on roads, or even on protected cycleways on the sides of busy roads: *"I felt more confident because you've got a group of people, so cars are more aware when they see a lot of riders."*

Group rides were ultimately a positive experience, even if the initial rides pushed participants outside their comfort zone. Once confident on the ebike, as the participant quoted below explains, the electrical motor assistance could provide an additional sense of security.

> "Being on an ebike gave me more of a sense of security, knowing that if I wasn't able to make it up hills … then I had the ebike to help me … around traffic, just having that little throttle … it was just brilliant."

In keeping with other ebike studies, identified benefits of ebike use included healthy exercise, convenience, fun, access to nature, as well as better mental wellbeing and savings on fuel costs. There were also barriers to use, namely safety concerns owing to the limited cycling infrastructure or a lack of riding confidence and fear of ebike theft. Although sturdy locks were provided to all participants, several individuals said they avoided using the ebike for routine trips to shops and other public places out of concern the ebike might be stolen. Fortunately, all ebikes were returned to TTT after both waves of the trial and only minor repairs were needed to the fleet at the end of the trial.

4.4. Trial 2: Triple Teez findings

Interviews were conducted with two TTT representatives. They also highlighted concerns over the potential for theft or damage to the ebikes. Guardianship of the equipment was experienced as a serious responsibility and underpinned the time consuming process of seeking confirmation (via in person visits or photographs) of where ebikes would be stored at home by participants. Personal safety of participants was addressed by allocating the ebikes based on an assessment of participants' riding skills during training sessions and group rides. As one TTT interviewee said: "*Together we did everything possible to manage the risks for people's safety."*

Also noted and valued was the flexibility to adapt aspects of the trial protocol during the trial period. For example, there was an option to extend the time participants had access to the ebikes, to account for the variable amounts of time it took for people to gain confidence riding the ebike and inclement weather over the trial period. This enabled the trial to *"actually go with the pace of our community and not just bombard people",* as well as accommodate those for whom a 20 km group ride was suitable as well as those who were more comfortable with a 5 km ride.

TTT noted that some participants considered the ebikes to be such an expensive item that they needed to convince them that they were entitled to have access to one for the trial period. Consequently, taking ebikes back from participants after they had experienced the benefits, knowing that most participants could not afford to purchase one, was an ethical concern for TTT and the research team. It reinforced the view that a mechanism was needed to enable regular access and longer-term use of ebikes in Māngere, and other lower-income areas. The team successfully sought additional funding through the central government transport agency, Waka Kotahi, and

the 'Hoe-ki-angitū' – Innovation Fund'. One objective of this government scheme was to investigate how under-served communities can gain greater access to transport, including support to implement a trial incentive scheme.

4.5. Trial 3: Pathway to permanence

Internationally there are many examples of ebike-incentive schemes designed to increase access and use. After reviewing options from the literature, four were selected and presented to participants in the Stage 2 trial: loan-to-own, a monthly lease (maintenance included), a community ebike library, and a purchase voucher. After a facilitated discussion around the characteristics of the different schemes, participants were asked to consider the advantages and disadvantages of each option with a view to supporting longer-term access to ebikes and increasing their use in Māngere. Firmly grounded in the promotion of bike use in the area, TTT representatives contributed their experiences to the discussion. At a later stage, participants ranked their preferences from a personal perspective.

The collective view favoured two options for the Māngere community, a point-of-sale discount voucher scheme and a community ebike library. A monthly lease was considered inferior to ownership, and potentially more costly over time. Loan-to-own raised negative associations with hire purchase agreements and fear of being liable for payment if an ebike was stolen. Although a discount voucher was one of two favoured options, it became evident in the course of the discussions that, depending on their circumstances, many participants could take up to two years to save the balance to buy an ebike of their own, even if a substantial voucher contributing up to 50% of the purchase price was made available.

Agreement from the funder was required before an incentive scheme could be implemented and a community ebike library run from the TTT Māngere community bike hub was preferred. Waka Kotahi had plans for ebike libraries in other communities and argued that the findings from a trial Māngere community ebike library would provide wide application. The ebikes purchased for the Stage 2 trial were to remain with TTT for an additional 10 months – for use in the ebike library trial.

Drawing on what has been learnt from the two earlier trials, the TTT Māngere community ebike library is currently offering *Give-it-a-go* workshops for novice ebike users, opportunities to take part in guided group rides, and for those who demonstrate satisfactory riding competency, a loan ebike for personal use for a limited duration. A longer-term loan arrangement was negotiated for a small group of riders from the Stage 2 trial who demonstrated substitution of ebike trips for routine car trips. Regular check-ins at the bike hub will be required to ensure the ebikes are well maintained.

At the time of writing the ebike library has not been evaluated. If the ebike library proves to be a successful means to make ebikes available to the Māngere community in ways that are valued by residents and extend transport choices, further funding will be needed to operate it on a permanent basis.

5. Discussion

Our iterative, strengths-based approach to trialling ebike use in Māngere has established that after being given a taster of what an ebike offers, participants were keen to access the benefits on an ongoing basis. These benefits mirrored those identified elsewhere: better physical and mental health, fuel cost savings, and the pleasure of riding. However, in this lower-income community the up-front purchase price of an ebike was prohibitive. Of 40 Stage 2 trial participants, only one had purchased an ebike six months after completing the trial. To support ebike access and uptake in communities like Māngere, incentive schemes and alternative models of community ownership are needed. Without this, the benefits of ebikes will remain centred in wealthier communities, limiting their effectiveness as a 'tool for transport equity' (McCullough et al., 2019).

Mode shift to active transport is difficult in a nation like Aotearoa - New Zealand, with its pervasive 'car culture' and associated infrastructure. However, the Māngere ebike trials generated interest in a suburb where ebikes had little prior visibility or availability. The trial started modestly, building through TTT's networks and using socio-cultural practices that resonated with the values of the largely Pacific and Māori community. TTT endeavoured to take the stress out of participating in the trial so that participants could concentrate on building their riding confidence, discovering new neighbourhood routes, and enjoying the experience. Support was always available and ebike maintenance taken care of. Also on offer were ebikes to accommodate larger bodies. It was important to TTT to have, or establish, a relationship with participants and reinforce values around safe cycling and respect for the equipment, the TTT team, and the community. Throughout, sights remained set on the bigger picture of supporting local people and growing a bike culture in Māngere.

The security of the ebikes was a concern for TTT and for participants, several of whom moderated their use of the loan ebike through their fear of theft. For TTT, security concerns contributed to decision-making around branding the ebikes as Māngere community bikes, a cautious approach to participant recruitment, and emphasis on fostering relationships with participants prior to releasing an ebike for their personal use. A similar cautionary approach has been to the fore in the process of setting up the community ebike library. Before ebikes can be loaned for take home use, borrowers need to join in a group ride, to ensure they have adequate riding skills but also to establish a relationship with TTT, one aspect of which is to safeguard the ebike. For the small number of Stage 2 trial participants selected to have longer-term access to an ebike through the library, their willingness to lead community group rides and contribute to growing the local bike culture was an important consideration. Finishing the trials with an ebike fleet well used and still available to the community was an ever-present goal for TTT. An aspect of cycling infrastructure highlighted by the trial is a need for more secure bike parking in highly visible public spaces in Māngere.

Flexibility was an implicit attribute of the trial process and TTT's way of working. Initially, three waves of participant recruitment were proposed, with a two-month ebike trial period. However, when it became evident further support and additional groups rides were needed to consolidate skills for a few individuals, the trial period was extended to three months and the number of waves reduced

to two. As well as working at the *pace* of the community, the trial needed to take account of TTT's capacity to manage the administrative, training and support aspects of the trial. Participants' support needs varied but were higher than initially anticipated. Almost half the stage 2 trial participants were Pacific people. Previous studies have found Pacific people are less likely to have ever learnt to ride a bike than non-Pacific people (Sullivan and O'Fallon, 2006) and Pacific households also have less access to working bicycles than non-Pacific households (Shaw and Tiatia-Seath, 2022), factors that may account for trial participants' support needs being higher than anticipated at the outset.

If ebikes are to be part of a just transition to a low-carbon future, active travel promotion and incentive schemes need to connect with the concerns and motivations already existing in communities (Lugo, 2013; McCullough et al., 2019). Solutions must also respond to the unequal geographical distribution of cycling opportunities, which adds layers of inequality to mobility (Edberg, 2023). Inequitable access to safe cycling infrastructure remains a critical issue (Braun et al., 2019; Ermagun et al., 2023; Padeiro, 2023; Tait et al., 2022), but interventions focused only on hard infrastructure investment within lower-income communities may not achieve significant increases in cycling participation (Tortosa et al., 2021). A just transition must also attend to the assemblage of factors that hold current mobility practices in place. Affordability plays a key role for lower-income communities with regard to biking, but other factors include the absence of a local bike shop or ride share opportunities, fears for personal safety, and a need for support to boost riding competence.

The Māngere ebike trials have gathered knowledge on an alternative approach to promoting ebike use that builds on the strengths and relationships of a community organisation and value of the 'human infrastructure' they provide (Lugo, 2013). It tilts towards an alternative assemblage that cultivates new mobility practices propelled by a local bike culture. However, subsidised access to ebikes is required to sustain and grow new ebiking practices in Māngere, and improvements to cycling infrastructure will help to embed these practices. A purchase voucher towards ownership proved an attractive incentive to trial participants, but schemes would need to remain open for several years to give people time to save the balance of the cost of an ebike. In the interim, options such as a low-cost community ebike library will be needed if continuous access is the goal. A full cost try-before-you-buy ebike library (e.g., $100 per week/month) may offer a successful pathway to purchase in wealthier communities but is less useful where the entry costs to ownership are well out of reach for households.

The trials also illustrate that with adequate funding, and armed with the necessary expertise and esteem, a community organisation like TTT can deliver a range of programmes for growing ebike access and supporting a local bike culture. Given Māngere's low rates of active travel, sustaining investment in programmes over time will be vital to increase the visibility of biking and ebiking and nurture a community-led bike culture. Without investment, mode shift away from motor vehicle dependency is unlikely, and lower-income communities like Mangere will remain locked into the mounting costs of high-carbon transport and barred from contributing to carbon emissions reduction targets, thwarting prospects of a just transition to a low-carbon mobility future. Furthermore, Māori and Pacific population groups cluster within many of the country's lower-income areas. Compared to other population groups, these ethnic groups experience poor health outcomes, including cardiovascular disease and diabetes, for which physical inactivity is a major risk factor (Jones et al., 2020; Ministry of Health, 2023; Shaw and Tiatia-Seath, 2022). Health is therefore a lever for change. In study in South Auckland, health and exercise were identified as key motivators for engaging in active travel behaviours; a sentiment poignantly addressed by TTT's moniker – 'To stay alive'.

The strengths of the research lie in the respected position held by TTT in the Māngere community, the codesign of the trial protocol, and the team's flexibility (including funders) to adapt and move in step with community aspirations. However, as with many 'real world' trials, there were challenges. Notably, accommodating the circumstances of participants, including a major flood event that displaced many Māngere residents from their homes during the trial period (Dine, 2023), which resulted in delays in post-trial interviews and data collection with some individuals. In turn, delayed data collection eroded the reliability of trip recall information and reduced the number of pre/post-trial comparisons on which to base the analysis of trip substitution. Odometer readings were also unreliable on a subset of the ebikes.

Notwithstanding these limitations, the research indicated an appetite for ebike use in the area, strong potential for their integration into daily travel, and significant trip substitution from motor vehicle to active travel. Much has been learnt from the series of ebike trails about supportive factors for ebike use in Māngere, including the need for sustained policy and investment to improve active travel opportunities in low-income neighbourhoods.

Conclusion

Ebikes are a convenient, low-carbon, healthy and fun form of transport. Their use is growing rapidly in Aotearoa - New Zealand and they have the potential to transform the way we travel. But ebike access is not equitable across our communities. This research has demonstrated an appetite for ebike access in Māngere and the potential for mode substitution from car to ebike. Increasing equity of access, and the health, environmental and economic co-benefits of their use, will require an effective model to support ebike access and uptake in lower-income communities. Likely characteristics of an effective model are adequate funding of community organisations to provide the 'human infrastructure' needed to grow local bike cultures; safe and secure on and off-road bike infrastructure; community ownership of an ebike fleet to support skill acquisition and social connection; and a pathway to low-cost ebike access and ownership.

CRediT authorship contribution statement

Karen Witten: Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Simon Opit:** Writing – review & editing, Investigation, Formal analysis, Data curation, Conceptualization. **Hamish**

Mackie: Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Ali Raja:** Project administration, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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