

RESEARCH ARTICLE

Health and well-being benefits of e-bike commuting for inactive, overweight people living in regional Australia

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Abstract

Introduction: Pedal-assisted electric-bikes (e-bikes) are bicycles fitted with electric motors. Motorised functions on e-bikes only operate when the user pedals, allowing riders a moderate amount of physical activity. This study aimed to explore the mental and physical health and well-being impacts related to ebike usage for inactive overweight or obese individuals living in regional Australia.

Methods: Twenty inactive, overweight/obese people who seldom cycled were provided with an ebike over a 12-week period. Individual semi-structured interviews conducted at the end of the trial generated data about participants' experiences of using ebikes. Inductive thematic analysis of interview data using Thomas (2006) data analysis framework and NVivo 12 software was undertaken.

Results: Data analysis revealed that e-cycling improved participants' mental and physical well-being and that they felt happier when riding an e-bike.

Conclusions: Riding an e-bike can improve mental and physical health, happiness and overall sense of well-being. Greater uptake of e-bikes would have positive health implications for the wider community. Results from this study can be used to inform active transport policy.

So what?: Our study demonstrated that encouraging active transport in the form of e-cycling can improve the overall health and well-being of overweight and obese Australians. More specifically, e-cycling demonstrated a positive impact on mental health well-being.

KEYWORDS

active transport, cycling, e-bike, electric bicycle, happiness, mental health, obesity, physical activity, quality of life

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1 | INTRODUCTION

Being overweight or obese and sedentary lifestyles have been long established as causal factors for health problems.⁴⁷ Recent studies^{6,15,17} highlight the benefits of e-bike use as one specific way to change commuter habits and in turn to improve health and well-being among urban and regional populations. However, few studies have examined the mental and physical health and well-being benefits of e-cycling for inactive individuals who are overweight or obese within regional areas. Two-thirds (67%) of all Australians are overweight, and regional and remote populations are more likely to be overweight or obese.^{1,2} Campbell et al's¹¹ systematic review and meta-analysis further supports the association between sedentary lifestyle and being overweight. However, the World Health Organization⁵¹ suggests that barriers for creating behavioural changes towards active transport modes is a result of a "lack of supportive policies" in the transport sector.

Although transport planning has been dominated by efficiency (Hannam et al, 2006;^{21,50}), in recent years there has been a shift in local and state government policies towards reducing car travel.^{33,38} This policy shift is a response to findings from studies about the environmental and health problems associated with passive transport.^{29,39,43,51} Although Australians commute on average 20 km or less per day, the vast majority of commuters (94.8%) still rely on passive transport modes and a significant proportion of commuters (79%) use a car.^{1,2}

Despite well-documented health and well-being challenges associated with passive travel modes, entrenched commuter habits make it difficult to create sustained behavioural change.^{8,31,40} Several studies sought to identify ways to incentivise change in commuter habits towards active travel modes, including that of e-cycling.^{24,53} However, the uptake of active travel modes in Australia is still very low (5.2%).^{1,2} Pedal-assisted electric-bikes (e-bikes), that is bicycles fitted with electric motors that operate when the user pedals, offer an alternate active travel mode for commuters.

Little research has been undertaken in Australia that examines the health and well-being benefits of using e-bikes as an alternative mode of transport, and none in regional Australia.²⁵ Langford et al²⁵ suggest that further research needs to be undertaken on health and well-being benefits related to the use of ebikes. A systematic review conducted by Bourne et al⁷ also suggests more research is needed to investigate the psychological impacts of using e-bikes. The purpose of this study was to investigate the health and well-being benefits of e-bike usage for inactive overweight or obese individuals living in regional Australia.

2 | METHODS

2.1 | Study design

A qualitative, individual semi-structured interview design was used. In this study each participant ($n = 20$) was provided with an ebike to use for a 12-week period. The interviews were undertaken post intervention

to explore participants' experiences of using an e-bike. Two twelve-week trials with ten participants in each trial were conducted.

Ten Giant pedal-assisted Lafree ebikes (provided by Giant Bicycle Co. Pty. Ltd.) were provided to participants to use during the study free of cost and returned at the end of the study. E-bikes were step through eight speed commuter style e-bikes, with hydraulic disc brakes.¹⁹ Bikes were fitted with a 36-V rechargeable lithium ion battery which was situated under the rear carrier rack.

2.2 | Participants

Participants living in Noosa, a small town in regional Queensland, Australia, were invited to participate in this research project through advertising in the local media, the Zero Emissions Noosa Facebook page and through Zero Emissions Noosa supporting organisations. Inclusion criteria for participants in this study were: 18 years of age or over, lived and worked in the study region, a basal metabolic rate (BMI) between 25 and 40, regularly drive their car to work, did not cycle often and were physically inactive (engaged in <30 minutes of moderate exercise on 2 days per week).⁴

Prior to participating in this study participants undertook pre-screening to test for their suitability to participate in this study. As part of this pre-screening to ensure they met the inclusion criteria, participants completed a short survey with questions about their physical health, and baseline blood pressure, pulse, and weight and height (BMI is calculated using kg/m^2) were measured. Those who had vital signs outside the normal parameters, that is, those whose resting heart rate was greater than 100 beats per minute and/or had a systolic blood pressure reading greater than 140 mm Hg, during the health checks were deemed as medically unfit and therefore were excluded from the study. Prior to using the ebikes, participants undertook a bicycle safety training workshop offered by Get Cycling (formerly known as Noosa Cycling). The workshop was approximately one and a half hours long and was conducted at the University campus.

At the end of their involvement with the study, participants had the opportunity to purchase the ebike they used at a reduced cost if they desired. Any ebikes not purchased by participants at the end of the trial were returned to the local Giant retailer for on sale.

2.3 | Data collection and analysis

Qualitative data were collected post-intervention by conducting individual semi-structured interviews (approximately 20 minutes in duration) to explore participants' experiences of using the ebikes. Topics covered during the interviews included how participants felt about using an e-bike, what they liked/disliked about using an e-bike, benefits and barriers to using an e-bike, whether they felt safe/unsafe when riding the e-bike, purpose for using the e-bike (transportation/leisure), if their travel habits would change after the study (why/why not?) and would they consider using an e-bike permanently in the future (why/why not?). Interviews

FIGURE 1 Qualitative analysis themes



were audio recorded and transcribed verbatim. The software program NVivo 12 was used to assist with qualitative data analysis. Inductive thematic analysis of data from interviews was undertaken. Data from interviews were de-identified then used in text to support themes and sub themes. Using an inductive approach, data from interviews were coded and sorted into themes and sub themes that described their core meaning.⁴⁶ The most relevant themes and sub themes were then used to develop a conceptual model.⁴⁶ Thematic analysis of data was undertaken by one research team member and then reviewed by a second researcher in the research team to ensure rigour and reduce bias.

2.4 | Ethics

Prior to commencement of this project, ethics approval was obtained from the CQUniversity Human Research Ethics Committee, approval number: 0000020887. Participation in this research was on a voluntary basis.

3 | RESULTS

Of the 20 participants who were in the e-bike trial, eight were female and twelve were male. All participants lived and worked

in the Noosa Shire. The average total distance travelled by e-bike during the trial was 320 km. The highest user rode 1282 km by e-bike during the trial (106 km per week) and the lowest user rode 5km over the course of the trial. Of the 20 participants, three purchased their own e-bike either during or directly after the trial, sixteen considered purchasing an e-bike in the future (cost was the main barrier) and one participant said they would not purchase an e-bike.

Participants reported both mental and physical health and wellbeing benefits from using e-bikes as an alternate mode of transport. Thematic analysis of data generated two major themes: *mental well-being* and *physical well-being* (see Figure 1). Under the theme *mental well-being* were the following sub themes: *feeling happy, feeling good, outside, noticing nature and social*. The sub themes under *feeling healthier* included: *exercise, feeling fitter, building muscles, weight loss and more energy*. A visual representation of results of thematic analysis is found in Figure 1. Results from thematic analysis will be explained next.

3.1 | Mental well-being

The theme 'mental well-being' emerged from the participants' descriptions concerning the positive effect of riding an e-bike on mental well-being. A resounding theme was the positive effect riding

an e-bike had on participants' mental well-being. Participants highlighted that the reason they rode their e-bikes was because of the impact e-bike riding had on their mental well-being. They explained how riding an e-bike lifted their mood:

When I go on the bike it is a good distraction if I'm not feeling happy or something like this so, it lifts me up.

(Participant 2, male)

So mentally, you feel better.

(Participant 10, female)

I felt more energetic and positive, and ... it's got good benefits for your mental health ...It made me a bit more confident, maybe? ... it's hard to describe, really.

(Participant 15, male)

Others spoke about how riding an e-bike helped them to clear their minds.

... and to clear my mind because you had no distractions and it's just everything in front of you ... I think that was the ... same thing again, because you've got nothing around you, I guess beside whatever you're passing, but it was definitely best way to clear your mind.

(Participant 6, male)

As highlighted in the conceptual model (Figure 1), the theme mental well-being was linked to feelings of happiness.

3.1.1 | Feeling happy

Overwhelmingly, participants described how riding the e-bikes made them feel happier. Some of the comments related to how riding e-bikes made the participants feel happy include:

I was certainly happier when I was riding the bike.

(Participant 14, male)

... the benefit for me ... would be mental health because it makes you really happy being out there on the e-bike.

(Participant 7, female)

Participants felt happier on the days they rode the e-bikes and were disappointed if something stopped them from riding the e-bikes:

I just felt happier on the days that I would ride it and I would feel happier knowing that I was going to ride it but then when it rained, or when there was something

that was going to stop me from riding, I felt a little bit sad because I couldn't ride it.

(Participant 5, female)

Linked to feelings of happiness, participants explained how they enjoyed riding an e-bike, all the more so, when using their e-bikes instead of their cars:

I really enjoyed it. ... In fact ... I was looking for opportunities to use it, and then instead of going in the car ... it ... just was brilliant.

(Participant 13, female)

Participants also described how they enjoyed riding an e-bike because it made them feel good.

3.1.2 | Feeling good

Participants articulated how riding an e-bike made them feel good and that often the reason they rode the e-bike was to improve their mood:

[The reason I rode it was] ... that I wanted to feel good ... it did make me feel good. So, riding it ... either I was feeling good and wanted feel better or I wasn't feeling so good and wanted to feel good. [I] just wanted to be outside in the fresh air, rather than driving the car.

(Participant 5, female)

Riding an e-bike created a sense of freedom for some participants:

I liked how you peddled it ... and it would take off ... I liked the feeling ... of a bit of freedom ... it was quite exhilarating sort of flying along. Wind blowing in your hair. (Participant 18, male)

Just ... the freedom of ... being able to ... go on a nice bike ride.

(Participant 12, female)

For some participants they found enjoyment riding an e-bike because it made them feel like a child again:

From day one, I loved it. I felt like a kid again because I hadn't rode a bike for such a long time. I really enjoyed the experience.

(Participant 14, male)

3.1.3 | Motivating

Riding e-bikes motivated participants to adopt new behaviours drinking less alcohol and smoking less. Benefits were described as twofold

by this participant, which were feeling better and therefore more motivated to do further activities. This participant explains how feeling better motivated them to join a gym and table tennis club:

... you feel better inside, I feel better because of all the endorphins ... that's generated me going to the gym obviously where I'm doing more exercise. And joined a table tennis club ... which will be more exercise. So that's it's encouraged things and out of all that I'm sure I'm feeling better.

(Participant 16, male)

Similarly, Participant 11 described how they were more motivated to do other activities and this increased motivation was directly linked to riding the e-bike:

I do 10, 11-hour days. Sort of big days a lot of the time. Physical work, and then, ... when I get home, all I want to do is sit on the couch ... and normally, by five o'clock I feel like that, but after a five, 10, 15-minute bike ride home, I get home and I'm all energised again ... And I ... emotionally felt good, too ... I had motivation to go and walk my dogs or ... do a bit of work in the garden ... I just found that ... little bit of physical exercise in the morning and in the evenings had just helped.

(Participant 11, male)

As a result of being in the trial and riding an e-bike this participant was motivated to cut down on the number of cigarettes they smoked each day.

... Definitely dropped back [on smoking] ... I just have less time to smoke as well, but now I know I need to get on the bike.

(Participant 17, male)

As a result of feeling good from e-cycling, this participant was motivated to quit smoking all together.

I stopped smoking ... I was always going to, but It did take a little while, but yes. I knew ... that smoking wasn't a healthy option.

(Participant 14, male)

3.1.4 | Outside, noticing nature

According to participants the e-bikes encouraged them to get outside more and explore the local environment. When they were riding, they commented on seeing more of nature. During interviews when participants spoke about seeing nature they would smile, as they recounted their memories. Participant 12 recalled their experience of being outside in nature:

Just being outside in the sunshine. I love being outside in nature... I loved going on that coastal track, being able to see the ocean and going through the trees.

(Participant 12, female)

Participants explained that in being outside riding their e-bikes, they started to explore new places:

We found places that we didn't even know existed. And with the exploring ..."Oh, I didn't know this had this here or this" You know, "This was here." We could be riding for over an hour and it was like, "Oh, I need to do more. I need to explore more,".

(Participant 13, female)

Without being on an e-bike this participant said they would not have been aware of regular pelican feedings occurring. They also describe how they took the time to stop and observe a flying fox colony, something they would not have done without the e-bike.

We ... coincided our ride ... and a beautiful sunset down the river... I didn't realise there's a guy that regularly feeds the pelicans down at the boat ramp. I didn't realise that was happening ... you'd stop and watch. ... On the way back ... we went in behind the library and deliberately wanted to find the flying fox colony ... I wouldn't have done or seen without the ... bikes.

(Participant 20, male)

3.1.5 | Social

Participants explained that being 'out and about' on an e-bike offered more social contact opportunities in the community. Riding the e-bikes offered a way to connect with others:

It was more, because they [people in the community] weren't used to seeing me, and then they got used to seeing me very quickly. And just how, it's only a matter of a week before you start the "Hello's", and then you get to know names, and then it was also just the fact, I think that the e-bike itself ... they knew what it was ... so a lot of people would ask questions about it.

(Participant 1, male)

3.2 | Physical well-being

Participants' perceptions were that they felt healthier because of riding the e-bikes:

I noticed my health improved ... yeah it makes me feel healthier.

(Participant 2, male)

Strength in my legs that's the biggest thing I've noticed.

(Participant 20, male)

3.2.1 | Exercise

The e-bikes were used to increase opportunities for exercise whilst commuting. The dual purpose of transportation and exercise was explained:

Feel like I'm getting some exercise, but I would often combine it with if I needed to go ... somewhere, to the shops. So, it was just a combination of ... having a reason for going out on the bike to go and pick something out from the shops, but also just enjoying ... getting there. That's the main thing that I enjoyed, rather than being in a car.

(Participant 12, female)

Participant 20 explained how the e-bike motivated them to get exercise; something that they would not generally do.

Even though it's not as much exercise as a normal bike, it's ten times more exercise because I don't walk. I don't generally do lots of other exercise, I know I need to, I don't. This is the one form of exercise I've actually been doing.

(Participant 20, male)

3.2.2 | Feeling fitter

Many participants described how they felt generally fitter because of riding the e-bikes. Increased fitness equated to increased work stamina:

My fitness has like gone up massively. Just my breath, my stamina at work and, leg muscles and stuff like that... just stronger. I have to bend over a lot to grab stuff and before it used to be a bit of a groan to stand back up, and now I'm just shooting straight back up, being a taller guy. Yeah, I can really feel the strength there.

(Participant 17, male)

3.2.3 | Building muscles

Muscle strength in legs was reported to have increased as a result of riding the e-bikes:

3.2.4 | Weight loss

Some described how they lost weight during the trial that was also appreciated by their spouse:

I've lost a small amount of weight since using it [e-bike]. Not a lot but it's something. I can feel that in my clothes as well. And my partner has commented, she says I feel and look a bit slimmer, so it's a good thing for me.

(Participant 16, male)

3.2.5 | More energy

In addition to weight loss, increases in energy levels were also reported making this participant feel refreshed and ready for work:

I feel healthier. I lost weight noticeably, in the scale and in the mirror. I just felt more active and more energised... I'd get up and ..., for the first hour or two of the day, I was ... slow to get going. When I was riding the bike, not so. I would just jump on and by the time I got to work, I was refreshed and ready to go.

(Participant 11, male)

4 | DISCUSSION

This study investigated the physical and mental health benefits of e-bike usage in regional Australia. We found improvements in mental well-being including feeling happier and more socially connected. Connecting with nature was also a positive outcome. Riding an e-bike created a sense of well-being (feeling good) and increased motivation in other areas of life too. We also found improvements in overall physical well-being. With increased physical activity came increased fitness, increased strength, increases in energy levels along with some weight loss. The e-bikes' motorised function enabled participation in bike-riding more readily. By participating in this trial, participants were able to influence others to consider e-bikes as an alternate mode of transport. An indirect benefit that emerged from this study was that following the positive experiences, participants were likely to encourage others in the uptake of ebikes. This finding is supported by Kairos (2010, as cited in,¹⁰ p. 3).

The benefits of active modes of transport have been well established, and there is a growing body of evidence to suggest that e-cycling benefits an individual's physical and mental health and

well-being.^{7,13,32,41,50} In their Norwegian study, Lobben et al²⁷ provided e-bikes to inactive participants ($n = 25$). Their study found physical activity levels increased significantly when participants were given e-bikes to use, which was similar to our findings, where participants expressed that they were undertaking more physical activity as a result of participating in the e-bike trial. The physical benefits of e-bike use, such as reductions in blood pressure and heart rates, are similar to some of the characteristics of conventional cycling albeit at a reduced intensity.^{6,7,12}

Compared to regular cycling, e-bike users still receive a moderate amount of physical activity.²⁵ Australian National Physical Activity Guidelines recommend “150-300 minutes (2 ½ to 5 hours) of moderate intensity physical activity or 75-150 minutes (1 ¼ to 2 ½ hours) of vigorous intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week.”³, para 10. Pre-screening revealed that prior to commencement of the trial none of our participants met the Australian National Physical Activity Guidelines. During the post-intervention interviews participants explained how riding the e-bikes increased their physical activity during the e-bike trial. In their European study, De La Iglesia et al¹⁴ developed an app for e-bikes. Similar to findings in our study, De La Iglesia et al¹⁴ found physical activity and fitness increased for e-bike users. In our study some participants reported that they felt stronger and lost weight as a result of being in the e-bike trial. According to Sperlich et al,⁴⁵ e-bikes act as an enabler for physical activity and promote muscles usage, suggesting e-cycling could be useful if incorporated into weight loss programs.

Physical activity is known to support mental health,²³ and our study confirmed those findings. A New Zealand study⁵⁰ explored e-bike ($n = 24$) experiences and reported on mental health benefits associated with getting outdoors and using an e-bike as a form of transportation. Moreover, social connectedness has also been linked with mental well-being.⁴⁹ A qualitative study by Spencer et al⁴⁴ highlighted how social re-connectedness happens through simple conversations with others occur during e-cycling. Our participants explained how social connectedness started with simple greetings such as “hello” with a passerby, and how these interactions would, over time, develop into conversations. Participants from our study explained that being outdoors on an e-bike improved social contact in the community, enabling them to connect more with others.

Happiness can be defined as when someone likes or enjoys their life, and is synonymous with well-being.⁴⁸ Consistent with findings from our study, Macaulay et al (2015) describe how e-bike users are happier, less stressed and more relaxed. Further, a survey conducted by McClellan³⁰ found that e-bike owners enjoyed using their e-bikes and gained enjoyment from riding their e-bikes. In their US study, Hoj et al²⁰ examined the health benefits of using e-bikes and reported that e-cycling improved mental health. These aforementioned studies support our findings that e-cycling increased happiness and overall sense of mental health well-being.

Despite a plethora of evidence to suggest that active commuters have higher levels of satisfaction with commuting (Friman

et al 2013)^{5,18,29,34,36,42,43,50}, there are still several physical and psychological barriers to the uptake of e-cycling as a preferred mode of commuting, especially for inactive individuals,⁶ (Cairns et al, 2015). As an alternative, the pedal-assisted component of e-bikes can alleviate some of the physical stress associated with cycling, therefore, it can reduce the barrier to cycling as a preferred commuter mode.^{22,28,37} With the correct infrastructure, environmental supports or policy to support e-bike commuters, access to e-bikes can increase the amount of cycling undertaken for leisure and for commuting.¹⁶

Evidence suggests that commuting to work on an e-bike (e-cycling) can have an improved effect on workplace productivity.³⁵ Similarly, participants in our study reported e-cycling increased their fitness and energy levels, and that they were more energised at work when they rode their e-bike to get there. This is likely to have had a positive effect on their work productivity. These findings suggest that businesses would benefit by having an e-bike fleet for employees to use or alternatively offering financial incentives for individuals to purchase their own e-bike. Another option for business would be to offer employees a fixed rate of payment per kilometre cycled⁵² to and from work.

Cairns et al¹⁰ report that car commuter travel can be reduced when participants are provided with ebikes to use as an alternative mode of transport. People with access to ebikes tend to use the ebikes for short trips thereby reducing local car commuter travel.¹⁰ More importantly in the Australian context, e-bike usage has been found to remain high for trips 20 km or less.²⁴ According to Ling et al²⁶ getting people out of their cars and using ebikes can potentially reduce car usage. Their USA study found that participant ($n = 806$) exposure to using ebikes promoted the concept of adopting ebikes as an alternate way of commuting. Cairns et al¹⁰ found around 70% of participants from their e-bike study claimed they would use ebikes again in the future. Similarly, participants in our study were more comfortable with the concept of using e-bikes as an alternate mode of transport, with a number purchasing e-bikes immediately after the trial period.

4.1 | Limitations

Limitations to this study include the small sample size ($n = 20$), the study was conducted in only one physical location and the selection criteria targeted a specific group of participants. Smaller sample sizes are common in qualitative research,⁹ Another limitation was that the study was carried out in one location, Noosa Shire, which is a regional area in Queensland, Australia. The final limitation is the selection criteria. Participants were those who lived and worked in the Noosa Shire, were overweight and not physically active. This means our findings may not be transferrable to other population groups. A strength of this study was that people were able to have access to an e-bike free of charge. This allowed a study design that is close to the real-world implementation of e-bikes.

4.2 | Recommendations

Suggestions from this study can be used to inform policy. Recommendations from this study include that firstly, Local Government Councils should consider promoting commuter choice by adopting e-bike fleets as an alternate form of public transport for the public to use. Secondly, to improve productivity for business, organisations with substantive numbers of staff should consider offering e-bikes or e-bike subsidies to staff. Thirdly, to improve the health and well-being of residents, local Councils and or employers should offer incentives to subsidise purchases of e-bikes, to promote e-bike usage in the community. Government subsidy schemes to offset the initial cost of an e-bike would accelerate community uptake of e-bikes. Finally, local governments should consider using e-bike trials/fleets to promote the social and environmental benefits of adopting e-bikes as an alternate mode of transport.

5 | CONCLUSIONS

This study explored health and well-being impacts related to ebike usage for inactive overweight or obese individuals living in regional Australia. The study found using an e-bike evokes feelings of happiness, results in mental and physical health benefits and improves overall sense of well-being. Encouraging active transport in the form of e-cycling can improve the overall health and well-being of overweight and obese Australians. Incentives promoting the use of e-bikes, would improve the mental health of Australians, and ultimately decrease health expenditure. Results from this study can be used to inform active transport policy with a view to increasing health and well-being within the wider community.

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CONFLICT OF INTEREST

Giant Bicycles Co. Pty, Ltd. Australia and Get Cycling did not impose any limitations on publishing the results of this study and had no involvement whatsoever in data collection and analyses. The outcomes of this research may benefit Giant Bicycles Australia as the research may result in future sales of ebikes. However, selling more ebikes was not the aim of this study for all parties involved. Giant Bicycles Australia may or may not use the outcomes from this study in their marketing materials, the authors have not had any

conversations about this. As stated by National Health and Medical Research Council of Australia (2007 Section 4), "research is expensive and often cannot be undertaken without the support of commercial sponsors".

ETHICS APPROVAL STATEMENT

This project was approved by the Central Queensland University Human Research Ethics Committee, approval number: 0000020887.

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