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Mini Review

Electric Bicycle Riding Improves Cardiometabolism in Moderately Active Adults

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ABSTRACT

The popularity of electric bicycles (ebikes) has recently soared with sales projected to grow to $119.72 billion by 2030. This trend is driven by their lower cost and eco-friendliness compared to gas-fueled vehicles. This mini review synthesizes findings from our laboratory and others, demonstrating that ebiking is exercise, ebiking is perceived as easier and more enjoyable than traditional cycling, and ebiking elicits important cardiometabolic benefits, including improved glucose regulation and decreased arterial stiffness.

Keywords: Electric bicycles; Cardiometabolic benefits; Exercise perception; Physical activity patterns; Public health implications thromboembolism

INTRODUCTION

Electric bikes (ebikes) have soared in popularity, with increased sales while regular bicycles sales have declined. A recent Forbes report valued the global ebike market at $37.47 billion in 2022 and projected it to grow from $43.32 billion in 2023 to $119.72 billion by 2030 [1]. Ebikes, equipped with battery-powered motors to assist pedaling, increase the speed and distance riders can travel. The appeal of riding faster and longer without a concomitant increase in physical effort increases the appeal of ebikes. While ebike motors offer convenience, there are concerns regarding whether this assistance may diminish the physical exertion traditionally associated with cycling, and thus compromise the health benefits of cycling. In simpler terms, many wondered “Is ebiking really exercise?”

Our group conducted a study comparing the cardiometabolic responses of ebiking (at two different assist levels) versus regular biking during a simulated 3-mile commute [2]. While ebiking resulted in reduced heart rate and energy expenditure compared to regular biking, the effort used to ride an ebike on the first assist level nevertheless reached physiological thresholds for heart rate (64%-77% maximal heart rate) and energy expenditure (~6 metabolic equivalents, METs) that met the recommendations for moderate intensity physical activity. This is the intensity recommended by the American College of Sports Medicine to achieve health related fitness benefits [3]. Notably, we reported the mean Borg Rating of Perceived Exertion (RPE, 6-20 Borg scale) when riding the ebike at the lowest assist level was 9.8 ± 2.2, categorizing it as "light" compared to the mean rating after riding a regular bike, which was 12.3 ± 2.0, corresponding to a perception of "somewhat hard". Additionally, the time taken to ride 3 miles on an ebike was approximately 2 minutes faster than on the regular bike. The reduced effort experienced by ebike riders in our study suggests that ebikes may help some overcome one of the most common barriers to adopting a more physically active lifestyle the perception that exercise has to be hard.

LITERATURE REVIEW

These findings are consistent with data reported by others [4-6], also indicating that ebike use, at a moderate level of assist, elicits an amount of physical effort at or near moderate-to-vigorous intensity. In a recent meta-analysis, McVicar et al. [7], further confirmed that ebike use, while less intense than regular biking, results in physiological responses that are likely to confer health benefits. The vast majority of these studies investigating ebikes have utilized healthy participants. However, Hansen et al. [8], evaluated the metabolic cost associated with ebike use at “low” and “high” levels of assist in patients with coronary artery disease (avg. age ~64 years), and similar to our study and others, both levels of assistance resulted in physical effort consistent with moderate intensity physical activity (energy expenditure>6 METs). Collectively these studies highlight the multifaceted

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nature of ebike riding, offering both convenience and a pathway to promoting physical well-being.

The majority of ebike studies have focused on evaluating whether or not using an ebike qualifies as "exercise". As we have discussed above, data from our lab and others indicates that ebiking does elicit the recommended intensity for physical activity. However, few studies have evaluated if ebike use results in the health and performance benefits associated with more typical exercise. In those examining the impact of ebike use on Cardiorespiratory Fitness (CRF), the results have been somewhat equivocal. Hochsmann et al. [9], compared changes in CRF between groups of healthy adults randomized to 4-weeks of ebike or "regular" bike use. While not statistically significant, the ebike group experienced ~1 MET increase in CRF, while the regular bike group had an increase of ~0.6 METs. A 1 MET increase may seem small, but it has been reported that an improvement of that magnitude is associated with ~19% decrease in CVD mortality and ~17% decrease in all-cause mortality in patients with CVD [10]. In a study utilizing a 6-week ebike intervention period, de Geus et al. [11], reported that ebike use for commuting resulted in significant increases in relative peak power in untrained men and women, but no significant change in CRF. Utilizing a prospective, quasi-experimental design, Lobben et al. [12], provided 25 participants with ebikes. The participants used the ebikes an average 107 minutes per week, and experienced a significant increase in CRF (~1 MET increase). While acknowledging the need for longer duration studies with adequate controls, the authors of a recent meta-analysis show that pooled data from the limited number of studies currently available, indicate that ebike use significantly improves CRF [13].

DISCUSSION

We have recently evaluated the impact of one week of ebike riding on patterns of physical activity and several cardiometabolic variables in low-to-moderately fit adults [14]. Using continuous glucose monitors to assess real-time glucose levels every 15 minutes and accelerometers to assess physical activity every minute for two weeks; we were able to quantify changes in glucose regulation before, during, and after physical activity of all types. Minute-by-minute physical activity was recorded by accelerometers worn by each subject, with the capability to sort the various activities into categories of walking, biking, sitting, standing, etc. Aligning glucose and physical activity measurements for two weeks (one with and one without access to an ebike) provided a unique observation of the relationship between physical activity and glucose regulation during two weeks distinguished by different physical activity patterns.

Baseline values of blood lipids, glucose, insulin, and body composition were compared between week 1, without an ebike, and week 2, with an ebike. Compared to week 1 without an ebike, ebike access resulted in decreased sedentary time and increased time engaged in moderate-to-vigorous intensity physical activity, which were determined by accelerometry to be primarily due to ebike riding. Two major cardiometabolic improvements that occurred during the week with the ebike included: Improved glucose regulation and decreased arterial stiffness-a novel, non-invasive, and independent predictor of coronary artery disease [15]. No changes in body composition, blood pressure, blood lipids, glucose, and insulin occurred in response to one week of ebike use.

Peterman et al. [16], also evaluated the potential impact of ebike use (4 weeks) on cardiometabolic values. Similar to our study, they reported no change in blood pressure, blood lipids, or fasting blood glucose. However, they did find that 4 weeks of ebike use elicited significant improvements in CRF (~0.7 MET increase) and improved glucose regulation in response to a 2-h oral glucose tolerance test. A limitation of these ebike studies is the short duration of the interventions, however, the rapid improvements in glucose regulation and arterial stiffness shown by these studies gives potential for a practical and relatively low cost intervention, especially with individuals diagnosed with pre-diabetes.

Additionally, there is evidence that ebike riding may improve cognitive function. While numerous studies support regular exercise/PA improving cognitive function, a recent study found that older adults who used either an ebike or conventional bike for three, 30-minute sessions per week for eight weeks improved executive function compared to non-cycling controls [17]. Additionally, participants riding the ebike improved their processing speed and mental health score, suggesting potentially greater cognitive benefits with ebike riding.

Recent data from the Centers for Disease Control and Prevention state that only 28% of Americans meet physical activities guidelines and that exercise varies widely based on geographic location [18]. Given that most studies comparing ebike and regular bike riding report similar outcomes, questions about preference and usage emerge as to which bicycle type is best suited for health interventions. Increasing the appeal of exercise by making it more fun and perceiving it as easy will likely increase participation in physical activity [19]. In our studies, ebike riding has been frequently described as being easy and fun [2,14]. A cloudburst of the most frequent reactions to riding an ebike indicate that ebike riding has high appeal (Figure1A-1C).

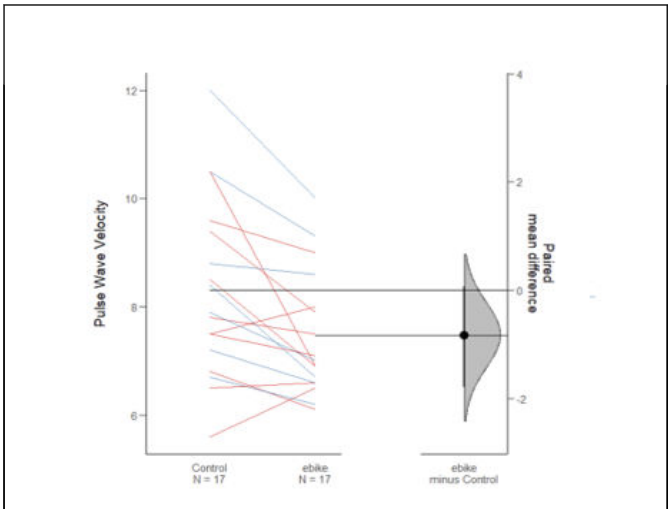

Figure 1A: Individual measures of pulse wave velocity (y-axis) with paired mean differences (z-axis) for male and female subjects. **Note:** (—): Female; (—): Male.

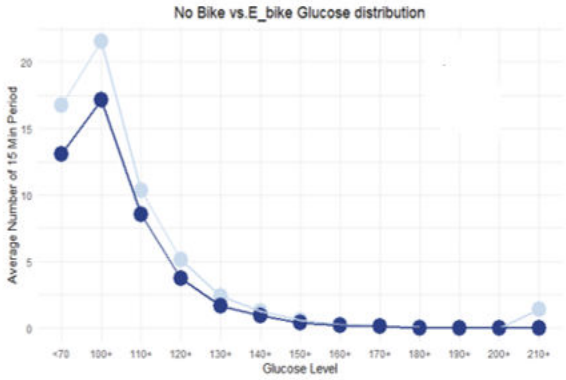

Figure 1B: Mean continuous blood glucose data during a week without and during a week with an ebike. **Note:** ( ): E_bike ; ( ): No bike.

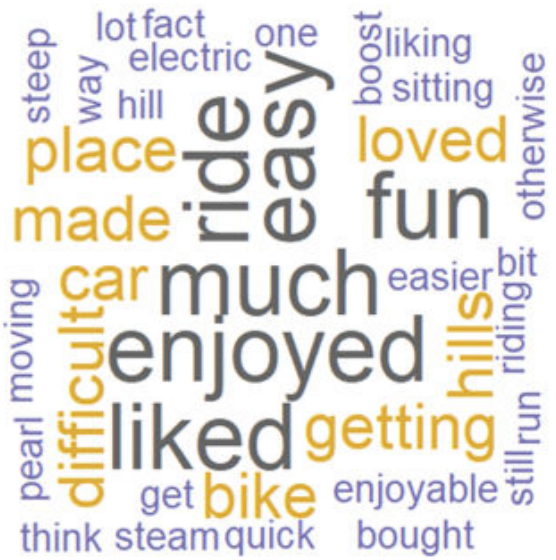

Figure 1C: Cloud burst of qualitative feedback on ebike riding [14].

Furthermore, our laboratory has reported evidence for two major short term health related improvements-glucose regulation and arterial stiffness. Future studies that target diseases known to benefit from increased physical activity will provide valuable insight as to the efficacy of ebikes as an intervention that focuses on lifestyle change rather than relying on a pharmacological approach. The value-added "fun", "easy" "liked" factors of ebike riding may increase appeal and adherence to actually riding a bike, becoming more active, and benefiting from regular physical activity.

CONCLUSION

In conclusion, the surge in electric bicycle (ebike) popularity reflects their cost-effectiveness and eco-friendliness compared to gas-fueled vehicles. Research indicates that ebiking qualifies as exercise, offering perceived ease and enjoyment while providing important cardiometabolic benefits. With potential cognitive enhancements and the potential to improve public health, ebikes present a potential impact for promoting physical activity.

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