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Electric bike (non)users’ health and comfort concerns pre and peri a world pandemic (COVID-19): A qualitative study

Khashayar Kazemzadeh *, Till Koglin

Transport and Roads, Department of Technology and Society, Faculty of Engineering, LTH Lund University, Box 118, 221 00, Lund, Sweden

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ABSTRACT

Introduction: The unprecedented COVID-19 pandemic affects different domains of society, including the transport system. Due to the impacts of social distancing, research concerning electric bike (e-bike) applications and non(user) health and comfort concerns is needed. This research aims to understand the health and comfort concerns of e-bike (non)users in both pre (PR) and peri (PE) pandemic situations and explore how the PE situation triggers (non)users to use e-bikes.

Methods: An interpretive description qualitative method in the form of semi-structured interviews was used to gather the empirical material for this research.

Results: Twenty-three (non)user participants were interviewed in the PR situation, and 12 of these participants were interviewed again in the PE situation. The comfort provided by the e-bike did not outweigh its cost as a factor for nonusers considering investing in the e-bikes in the PR situation. However, nonusers acknowledged that e-bikes can serve as substitutes for public transport by eliminating social interactions and consequently potential health concerns, in addition to providing comfortable mobility. E-bike users were in agreement concerning physical activity and the health benefits of using e-bikes in the PR situation. Their opinions differed slightly, as women placed less emphasis on the physical activity provided by e-bike use. However, gender opinions converged regarding health concerns about using public transport in PE situations. Infrastructure facilities and e-bike performance are evident as users’ comfort concerns in the PE situation.

Conclusion: The results highlight the role of the e-bike in PE situations as a reliable transport mode and suggest that there is considerable potential for e-bikes as substitutes for public transport in the post-pandemic situation. The findings are applicable to e-bike level-of-service studies in order to provide an overview of the user’s experience of comfort.

1. Introduction and motivation

Cycling is an active and environmentally-friendly transport mode that has received support from governments across the globe (Chen, 2019; Chen and Lu, 2015; Melson et al., 2014). Cycling provides extensive benefits for both users and society, such as the enhancement of health and reduced CO2 emissions and fuel consumption (Hood et al., 2011; Leao et al., 2017). Also, cycling could replace many car trips, consequently improving public health (Raustorp and Koglin, 2019). In addition, cycling suggests a transport mode with fewer social interactions compared to public transport—a critical advantage in the case of infectious diseases such as the
COVID-19 pandemic. This subject calls for more extensive studies to evaluate and improve comfort and health as they relate to cycling.

In order to evaluate quality of service from the user’s perspective, the concept of level-of-service (LOS) was introduced by the Highway Capacity Manual in 1965 (Highway Capacity Manual, 2010). The LOS index translates users’ perceptions of comfort for each mode of transport, such as motor vehicles, public transport, walking (pedestrian), and cycling (Nikiforidou et al., 2020; Wong et al., 2017). In the cycling research domain, Davis (1987) documented the first so-called cycling LOS/safety index (Davis, 1987). This concept has since been further circulated in the field of cycling (Beura et al., 2020; Botma, 1995). The main process involved in LOS estimation is to aggregate/model the important variables that are associated with users’ comfort and present them on a letter scale, often from A (best) to F (worst) (Jensen, 2007). Each index considers a specific range of variables and is based on different contexts. Although extensive cycling LOS research has been conducted over the last three decades, electric bike (e-bike) LOS—despite it being a frequent active transport mode—has been less studied in this field (Kazemzadeh et al., 2020b).

E-bikes require less physical energy to operate (compared to a bike), can enhance rider health, and have low maintenance costs (Fyhri et al., 2017; Jones et al., 2016). E-bikes also provide a sustainable and healthy transport mode, with fewer emissions compared to motorised vehicles (Liu and Suzuki, 2019). Besides the environmental advantages of the e-bike, there are economic benefits in terms of total cost per kilometer travelled compared to a gasoline scooter (Weinert et al., 2007). E-bikes could be considered a new approach to mobility, especially for countries with environmental concerns and high populations (Salmeron-Manzano and Manzano-Agugliaro, 2018). Considering these advantages, the e-bike has been acknowledged as a fast-growing mode within the transport market (Fishman and Cherry, 2016; Schepers et al., 2020). However, few scientific studies have addressed the comfort, LOS, and health concerns of e-bikes (Bai et al., 2017; Kazemzadeh et al., 2020c; Langford et al., 2017).

The objective of this study is twofold. First, we explore the comfort and health concerns of e-bike nonusers in pre (PR) and peri (PE) pandemic situations. The goal is to explore the underlying complexities regarding the reason not to use an e-bike in the PR situations. This analysis is extended to evaluate whether the PE situations (e.g., social distancing recommendations) trigger nonusers to purchase and use e-bikes. Second, we explore the concerns of e-bike users in PR and PE situations. An understanding of user’s concerns in PR situation provides useful information to evaluate and improve facilities for users. Expanding this evaluation in the case of the PE situation is crucial as users experiencing e-bike under different mobility conditions (e.g., less motorised traffic, significant restrictions on public transport options) which may change user’s concerns and consequently their requirements. The health concerns addressed in this paper focus mainly on the physical activity of users and their opinions about the health advantages of using an active transport mode—in this case, the e-bike. Users’ health concerns due to the social interactions of daily travel in PE situations have also been studied in this research.

2. Background

E-bikes can be categorised into three types: pure e-bike, power-assisted e-bike (pedelecs), and a combination of the pure and power-assisted types. In the pure type, the rider does not need to pedal, while pedelecs reduce physical exertion through a computer-guided electric motor (Plazier, Weitkamp, & van den Berg, 2017). A combination of the first two types introduces the third type (Hung and Lim, 2020). In this study, the term “e-bike” refers to the second type, pedelecs. E-bikes can be classified as bikes in the transport network if they meet different criteria. For instance, in Europe, maximum speed should be limited to 25 km/h (Fyhri and Fearnley, 2015). Previous research has addressed the different characteristics of e-bikes.

There has been extensive research regarding the sociodemographic characteristics of e-bike users and the factors influencing usage. The ease of e-bike riding could attract a wide range of users, including the elderly and users with physical health problems. A great body of research has explored the potential opportunities for, and advantages provided by, e-bikes for the elderly. For instance, Johnson and Rose (2015) conducted an online survey among elderly people in Australia. They reported that replacing an e-bike by car is the dominant mode of change across all trip purposes. Also, respondents reported that they usually felt safer riding an e-bike than a pedal bike. Schleinitz, Petzoldt, Franke-Barthold, Krems, and Gehlert (2017) claimed that, as e-bikes regularly reach higher speeds than bikes, participants over 65 years of age rode significantly slower than younger participants. Van Cauwenberg et al. (2019) explored reasons for purchasing e-bikes among the elderly. The most dominant reason for using an e-bike for both genders was the lower effort required compared to a bike. This comparison of genders also revealed that men use e-bikes primarily for recreation, whereas women use e-bikes to a greater extent for social activities.

The age and gender characteristics of e-bike riders have been discussed mainly in safety studies related to e-bikes. Haustein and Møller (2016) conducted a study in Denmark to explore the factors contributing to e-bike riders’ perceived safety and the factors involved in critical safety incidents. They reported that age and gender (female) user characteristics were negatively related to the perception of safety. Guo, Wu, Lu, and Zhou (2019) documented the risk factors associated with the severity of e-bike accidents. They reported that age and gender, among other variables, are related to the severity of accidents. Bai, Liu, Guo, and Yu (2015) compared the risky behaviours of two groups of riders in China, including bike and e-bike (and e-scooter) riders. They claimed that the gender and age of riders in the second group significantly influenced risky behaviour at signalized intersections.

The ease of e-bike riding introduces the possibility of substituting transport modes such as cars and public transport with e-bikes. Ye, Xin, and Wei (2014) discovered that e-bikes are mostly used for commuting, with an average distance of 9.5 km and an average time of 27.3 min. They reported that the main boosting variables for e-bike use are saving time and money, comfort, and convenience. Wei, Xin, An, and Ye (2013) emphasized that the over-standard e-bike competes with the bike and public transport, and that users are eager to cover longer travel distances with an e-bike. They also stated that motorised vehicles are used as replacements when e-bikes are not available. Cherry, Yang, Jones, and He (2016) investigated the use of e-bikes in China over six years. They reported a decreasing trend in bike and bus popularity and a rising trend in car and taxi popularity. However, they emphasized the role of e-bikes
as an interruption of this shift to motorised vehicles, increasing the possibility of a shift to personal mode. They stated that e-bikes are efficiently replacing many urban car trips.

Xin et al. (2017) evaluated the travel behaviour of e-bike users based on prospect theory and concluded that e-bike riders prefer to use the subway rather than buses for long-distance travel. This decision is made due to the low quality-of-service of buses. Sun, Feng, Kemperman, and Spahn (2020) examined the changes in travel that occurred when users owned an e-bike. They found that, after adapting to e-bike use, bike usage decreased, with car usage decreasing to a lesser extent. They stated that rural e-bike users tend to drive less after adaptation to e-bike use; this trend is more apparent in rural, as opposed to urban areas. Wild and Woodward (2019) stated that e-bikes could facilitate situations on daily trips that influence the time reliability of cyclists, such as wind and tiredness.

In Scandinavian countries, previous research has evaluated the different characteristics of e-bike riding. As an example, Fyhri et al. (2017) conducted a study in Norway and documented that less cycling is correlated with greater interest in purchasing e-bikes. They reported that the experience of using e-bikes could stimulate the use of e-bikes. Bjornarå et al. (2017) focused on the parents of kindergarten children who used e-bikes, longtail bikes, and bikes for transport. They claimed that there is a need to study the effect of e-bikes and longtail bikes on travel behaviour and physical activity levels. Winslott Hiselius and Svensson (2017) evaluated the e-bike using changes in travel behaviour in Sweden. They reported that, similar to urban areas, car trips could potentially be substituted with e-bikes in rural areas. Thus, the fast-growing use of e-bikes calls for more extensive research evaluating various aspects of this transport mode.

3. The pandemic (COVID-19) situation and the Swedish approach

The concept of the pandemic has been referred to different global epidemic events, such as diseases with various epidemiologic features (Morens et al., 2009). The World Health Organization (WHO) has declared different pandemics over the past couple of decades, such as the SARS outbreak in 2003 and the H1N1 influenza virus in 2009 (WHO, 2009). In March 2020, the WHO declared the coronavirus (COVID-19) a new world pandemic. The transport domain is an integral part of everyday life, and it is crucial to have an in-depth understanding of the health and comfort of its users, specifically in the case of pandemics. During this pandemic, social distancing has been introduced as a remedy for reducing interactions among people, as some individuals may be infected with the virus yet unaware that they should be quarantined (Wilder-Smith and Freedman, 2020). Social distancing has resulted in a transformation in travel behaviour and decreasing ridership in car traffic and public transport. Consequently, the rideshare of active transport modes has increased and this mode is highlighted to address social distancing issues in the transport domain. (De Vos, 2020).

COVID-19 has imposed a novel pandemic on the world. The pandemic is unique, with an unclear amplitude; however, it has had a destructive impact on the world economy. Different countries have applied different strategies to control the impact of the pandemic. For example, France and Germany applied relatively strict lockdown policies and authorised the society to open up gradually, based on scientific suggestions (Pierre, 2020). In Scandinavian countries, different policies have been applied to combat the pandemic. Denmark and Norway have introduced strict policies, including travel restrictions to/from their countries, closing schools, and limitations on business activities (Conyon et al., 2020). In contrast, compared to its neighbours and other countries, Sweden has implemented less strict strategies to contain the pandemic. In Sweden, instead of a complete lockdown, government policies were adapted to reduce visits to high density neighbourhoods. The Swedish government also opted to “recommend” and “advise” rather than “legislate” social behaviour (Capano et al., 2020). Also, public transport was advised to keep passenger levels low to avoid crowding, while people over 70 years old were encouraged to avoid using public transport altogether (Folkhälsovårdens, 2020).

The transport system can reflect a pandemic situation via travel pattern changes. Jenelius and Cebečauer (2020) evaluated travel pattern variations due to the COVID-19 pandemic in three populated areas of Sweden. Public transport ridership had dropped by 40%–60% in different regions. The analysis was based on different variables such as the datasets of ticket validations, sales, and by counting passenger data. No drop was observed in bike flow; rather, it increased in the out city. However, this trend started before the pandemic. The extensive downward trend in public transport ridership in Sweden, combined with less strict lockdown legislation, calls for more research to understand users’ perspectives regarding active transport, especially e-bikes.

4. Method

It is crucial to have an in-depth understanding of people’s perceptions, attitudes, and travel behaviour. On the one hand, qualitative methods enable researchers to tackle the complexity of travel behaviour characteristics (Beirão and Sarsfield Cabral, 2007). On the other hand, interviewees are free to express their own perceived descriptions of travel behaviour. As emotion plays an indispensable role in the travel decision-making process, qualitative methods are a powerful tool to scrutinise users’ emotions without the limitation of quantitative methods (Grosvenor, 2000). Allowing users to describe their feelings and emotions in their own words is a critical advantage of qualitative methods compared to quantitative tools. The freedom for users to express their concerns helps the researcher to consider predefined variables; it also allows for the exploration of more individual preferences. Furthermore, qualitative methods provide rich behavioural data on a relatively limited sample of the population (Patton, 1990).

4.1. Sampling approach

Researchers can employ different sampling techniques, such as probability and non-probability methods. In the probability-based sampling technique, a random selection process provides each unit of the population a known nonzero probability of selection. In non-probability methods, subjective methods contribute to inclusion and exclusion in the study sample, and randomisation is not
considered for sample selection (Gary, 1990). Convenience sampling, also called haphazard or accidental sampling, is a type of non-probability method in which the unit of the target population is selected if they fulfil specific criteria. These criteria include ease of accessibility for the participants, geographical proximity, availability at the time of research, and participation enthusiasm (Etikan et al., 2016).

In this study, the convenience sampling method was used as the procedure for participant selection. Potential participants had to meet different criteria to be selected for the study. First, they must be residents of Sweden. Second, they have been an e-bike rider or have had an e-bike riding experience. They were also required to be able to use the internet (social media platform) for the interview process. As the interview was voluntary and participants were not offered a financial reward (except for the cost of data usage for the interview), they should be willing to participate. Fig. 1 classifies participants based on their age, gender, and e-bike ownership in both PR and PE situations.

4.2. Data collection

Data collection in the pre-pandemic (PR) situation was performed in January 2020, while interviews regarding the peri pandemic were performed in April 2020. Participants were selected via various announcements at the Lund University campus. Also, the authors itemised potential participants from their contacts at colleges and different university faculties. These requests were done mainly via telephone and social media. The contacted participants were first matched with the research criteria and, after confirming their suitability for participation, were listed for interview appointments. All participants were contacted before the interview and provided with a short instruction about the interview. They were informed of the approximate duration of the interview (less than 1 h) and the purpose of the study. This research, which is based on 23 interviews, was conducted mainly via social media platforms (video call). Interviewee selection was performed in such a way as to obtain a good distribution of users. The age range of users ranged from 21 to 76 and comprised 15 females and 8 males. All participants were residents of Sweden, although some were not in Sweden at the time of the interview. These participants were mainly on vacations/trips.

4.3. Participant classification

A total of 23 persons were interviewed in the PR situation, and 12 persons (from the PR sample) were interviewed again during the PE situation. The selection of participants in the PE was based mostly on the availability of users and whether they were interested in participating further in the research. The authors contacted all participants after the first phase of the experiment; however, 12 participants agreed to participate in the second phase.

Participants were informed of the purpose of the study: to understand their comfort and health concerns regarding the use of e-bikes. The interviewee was informed that the interview would be completely anonymous, and they could terminate the interview at any time. Each interviewee was also informed that they could have a transcript of their interview. No rewards or external motivation were considered for the interviewees; they dedicated their time to help the research. However, although they were offered reimbursement for the cost of the internet (data usage) to conduct the video call, none of the participants requested this.

4.4. Interviews and analysis

Semi-structured interviews were conducted to understand the users’ perceptions of comfort and health concerning the use of the e-bike. Participants were also encouraged to express their ideas spontaneously and different follow-up questions were prepared and used according to the participants’ answers. Examples of questions are included in Appendix. Most interviews took place in the afternoon and lasted 20–40 min. The interview process was audio-recorded and written down by the authors. Detailed discussions were recorded and transcribed from the audio-recorded documents (excluding warmup discussions). At the beginning of the interview, a general description of the purpose of the interview, confidentiality terms, and estimated time of interview were provided. Also, to avoid any misunderstandings during the interview, the type of e-bike (pedelec) under discussion was clarified for the interviewee. At the end of each interview, general points derived from the person’s opinion were validated with the participant. The participants’ responses were again validated with them (mostly via telephone) after completing the post process of interview data. They were informed that they

Fig. 1. The distribution of participants’ characteristics in PR and PE situations.
could contact the study researchers to obtain a transcript of their interview.

Different methodological approaches can be employed for qualitative content analysis, such as inductive and deductive methods. In the inductive method, researchers try to find patterns (similarities and differences) in the study data. The method is also called data-driven because the researcher is navigated from the data to a theoretical understanding. In the deductive approach, the researcher evaluates the applicability of existing theories to the collected data. This method is also called concept-driven (Graneheim et al., 2017). The inductive approach was employed in this study to find patterns among non(users) in PR and PE situations.

To store the data, a spreadsheet was assigned for each person, and all responses (even marginal opinions about general facts) were noted. The results were written either in a spreadsheet or on paper at the time of the interview. After the interview (and initial analysis of the audio-recorded documents), all results were post-processed and refined to be coded. The data analysis was performed after the post-process and transcripts were carefully read several times. The transcribed data were labelled during the first step of the analysis. Then, the in-vivo coding technique was used for coding transcribed data (Strauss, 1987). In the in-vivo technique, codes are directly quoted from the transcript and this process helps that analysis to be based on the data. For instance, the in-vivo codes vividly reflect the concern of e-bike users in the case of PE situation such as battery concerns including heavy frame (in the case of being out of charge) and the lack of bike racks (and bike parking). In order to cluster respective arguments, constructive labels were assigned such as e-bike performance and infrastructure facilities, respectively. This coding technique was used in previous studies in the transport field (Hung et al., 2013; Milakis et al., 2015). The transcripts were reread after the code assignment in order to spot any potential issues with the coding system. To ensure confidentiality, all personal information in the spreadsheet was converted to participant numbers.

5. Results

To gain a better understanding of the results, the outcomes were classified based on nonusers and users (owners). The PR and PE situations were also discussed within each group. To reveal the patterns of e-bike (non)users’ concerns in the PE, the opinions of the same users were matched in PR and PE situations. This way of organising contributed to a simultaneous comparison of the participants’ opinions in both situations.

5.1. Nonusers in PR and PE situations

Fifteen persons did not own an e-bike at the time of the interview. However, all had the experience of riding an e-bike. One of the significant points in this category is to understand the users’ reasons for not purchasing an e-bike. In the PR situation, one of the dominant reasons—one that prevented the nonusers from purchasing an e-bike—was the expensive cost of owning an e-bike. In most cases, nonusers argued that having an e-bike would be very expensive and, since they would not use it daily, not very beneficial. This group often used their bikes for most trips and public transport for longer trips. It could be important to understand how much people are willing to pay for the perceived riding comfort of e-bikes. Some users (mostly young adults) chose to walk for their short trips and used their bikes for longer trips:

“I walk for short trips and usually have the bike for relatively long trips. I have the experience of using an e-bike for a research study, in which I rode an e-bike for a couple of hours. I think it is cool, but when I consider its price, it would be very expensive to own it compared to the use of public transport […]. To me, as a person who does around 80 percent of her trips by bike, it isn’t worth it have the e-bike and keep it, charge it, and use it every second week. […] It may be more beneficial to have e-bike sharing stations or pick up places, like scooters, though it should be cheaper than the bus.” (female, aged 27)

In contrast, in the PE situation, it was revealed that this group likes to invest in purchasing e-bikes, and they perceived the value of the e-bike for long-distance travel. In some cases, they do not want to have an e-bike as their primary mode of transport, but as a complementary mode along with the bike:

“I have never thought that one day using the bus would be stressful because of Corona and being close to other people. I use my bike on most of my trips but I have to visit my parents and some other activities which are too far to be reached by bike. I think it is useful to invest some money to buy an e-bike and to feel safe being able to travel long distances at any time. Even the feeling of convenience of having an e-bike ready in my place is good […] On the economical side, having one would also eliminate all of my bus and tram ticket costs.” (female, aged 27)

Another strong reason for not purchasing an e-bike among nonusers was the perceived physical inactivity caused by using an e-bike. Nonusers mostly admire the bike because it requires physical activity. Although all participants had an experience of using the e-bike, some thought that using an e-bike would result in decreased physical activity, as described by a 21-year-old female:

“I go to the gym almost every day, though I like to consider my pedalling an everyday activity. I know if I were to buy an e-bike I could not maintain my weight since I use my bike for most trips. […] Sometimes when going uphill I see e-bikes easily pass me, and I understand that it makes traveling much easier. But still, I don’t think it would be that helpful for me.”

Public transport has been used by nonusers as a complementary transport mode in PR situations, facilitating long-distance travel with active transport modes for short-distance travel. For long-distance travel, most public transport users are concerned about social interactions in the PE. They indicated the importance of the e-bike in the PE; they like to have an e-bike and to use it along with a bike for long-distance travel. In the PE situation, this group also acknowledged the convenience of the e-bike for unexpected trips:

“I think it is good to have an e-bike in this chaotic time. Now I don’t use the bus as much as I can. Sometimes I have to, and I wear a mask, but I don’t feel very safe. Also, I feel that if I need to make an emergency trip, I can’t easily opt for the bus, and it is good to have an e-bike
For nonusers, the primary reason for not having an e-bike in the PR situation was the higher cost of an e-bike compared to a bike. The cost aspect is critical, as it can be an indication for how much e-bike riding comfort can motivate nonusers to purchase one. For instance, the small number of times they would need an e-bike for long-distance trips is a disincentive for purchasing one. Less physical activity compared to the bike was the second most-commonly given reason for nonusers not purchasing an e-bike as their dominant transport mode. In the case of the PE, some e-bike nonusers would be willing to pay for an e-bike for use in PE situations. Health concerns—the result of worries about social interactions on public transport in the PE situation—were a crucial factor that amplified nonusers’ opinions towards purchasing an e-bike. They appreciated the value of the e-bike as a way of tackling the difficulties involved in long-distance travel. Some nonusers also noted that they would prefer to rent an e-bike in the PE, or have an e-bike temporarily, rather than purchasing one. Government financial assistance for current e-bike nonusers could help to overcome high initial investment—an acknowledged obstacle to purchasing e-bikes.

5.2. Users (owners) in PR and PE situations

In the PR situation, eight of the 23 persons interviewed owned an e-bike (one person had two e-bikes). However, all participants had the experience of e-bike riding. The users strongly believed that the e-bike provided them with physical activity and thus kept them healthy. Some users used their e-bikes for all possible trips within their city, and in some cases to commute to another city (in this case, Lund to Malmö, two cities in the southern part of Sweden). However, some users (mostly women) coupled their trips with bikes for shorter trips, and often coupled bus and train modes for long-distance trips of more than 25 km. In some cases, users coupled their trip plan with the bike to reduce their worries about parking facilities and fear of theft, as noted by a 30-year-old female:

“I basically use my e-bike for all possible trips, including school, grocery store, gym, and parties. Sometimes, I worry about finding a proper bike rack in the city and don’t bother to take my e-bike. I would rather use my bike, which I can leave anywhere […] I don’t really count on an e-bike for the physical activity. I just use it for transport since I often go to the gym every evening.”

Twelve persons were interviewed again to understand their opinions in the PE situation concerning the use of the e-bike. Often, the differences in long-distance trips were highlighted for users in the data analysis process. For example, the same person in the PR (female, 30 years-old) was re-interviewed in the PE situation:

“I used to do most of my trips by e-bike in daily life before Corona and use the bus on some sort of long-distance trip. I mean, when I wanted to go to Malmö [“from Lund”–authors’ note], I always used the bus or, rarely, the train. But now, it is a bit uncomfortable to use the bus because of Corona and instead I use my e-bike. I feel safer. But I have never used my e-bike before for such a long trip and now I think I am a bit worried about the battery charge for a long-distance return trip but still better than feeling unsafe in the bus. Sometimes I am a bit worried if I run out of charge. It would be difficult to get back home as my e-bike is heavy.”

The practical performance of the e-bike was highlighted in the case of the PE situation. Battery life span and the weight of the e-bike were documented as the most important comfort concerns for users in the PE situation. However, users considered the e-bike to be the most reliable means of transport for most of their trips. E-bike users have a slightly different opinion (gender-based) about the e-bike and its physical activity and health benefits in the PR situation. Physical activity was less a concern for the women than for the men in the PR situation. Men admired the opportunities provided by the e-bike for both physical activity and transport. Hence, they felt that e-bikes could simultaneously encourage physical activity and improve their health. The results suggest that women in the PR situation have more robust and regular workouts and do not link physical activity with transport activities. On the other hand, in the PE situation, women’s opinions concerning the physical activity provided by the e-bike shifted to a more positive assessment. This is due mainly to the conditions of the pandemic, with recommended social distancing in public places such as gyms. The PE situation provides an opportunity for women to consider the e-bike as a complementary physical activity while they use it as a transport mode. Switching from e-bike to bike and vice versa also presented a plan for physical activity coupled with workout activities:

“I go to my office by e-bike every day; my office is kind of close to my home, like 10 minutes, but I like e-bike convenience, especially in the morning. Usually, in the evening I turn off my e-bike and just use it as a bike. I feel that it is a proper physical activity since the e-bike is heavier than my bike. Most of the time, I plan my trips based on the grade of my trip; for downhill, I turn off my e-bike and save the battery for the uphill.” (male, aged 31)

As it was for women, concerns about e-bike performance in the PE were also highlighted for men. The same person, male, aged 31:

“It is good that I have an e-bike and I feel it is comfortable for my trips, but at the same time I am worried about my battery. Usually I carry my battery charger whenever I plan a long-distance trip […] probably it wouldn’t be a big deal to ride it as a regular bicycle, but I imagine that a long-distance trip back home without energy would be difficult.”

As mentioned, the role of the e-bike as a means of physical activity was less highlighted in the PR situation for women. However, women counted on the e-bike much more to provide physical activity (often as a substitution for the gym) in PE situations. Here is the opinion of the same person, a 23-year-old female, in the PR situation:

“I like my habit of going to the gym and it is actually part of everyday life. I feel that I should keep the gym exercise separate from biking activity; otherwise, I feel that I don’t really workout […] I use my e-bike to get to school because I have a long uphill ride and usually on the way back I visit friends or go shopping.”

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activity provided by the e-bike:

“I am very happy to use my e-bike for all my trips in the city now […]. It saves me time and at the same time I use it as a workout activity. These days I don’t feel like going to the gym because of the virus, and I shift my e-bike to bike sometimes for more physical activity. The best part of having an e-bike now is that I don’t need to use public transport for any reason and I feel safe cycling wherever I want to go.” (female, aged 23)

The choice of the e-bike in the case of PR was influenced by several factors, including the comfort of riding the e-bike, unreliable public transport schedules, the cost of a bus ticket (mostly in the case of a single ticket), and saving time. The influencing factors are mostly connected to public transport factors. For instance, those users who experienced some difficulty with the cost and timing of public transport considered the e-bike a remedy for their travel schemes. In addition to users’ riding comfort variables in the PR, the feeling of being safe (in terms of social interaction) was the main advantage of the e-bike over other transport modes in the PE situation. Regardless of the performance deficiency (based on some users’ opinions), the e-bike was acknowledged mostly as the best mode of transport in the case of the PE.

6. Discussion

Many governments across the world encourage cycling as an environmental-friendly transport mode. These efforts are important steps towards improving cycling’s modal share. The e-bike is an active transport mode that enables riders for long-distance travels. The benefits of the e-bike as a means of long-distance travel and as a way to ensure social distancing (compared to public transport) introducing it more interesting especially in the case of pandemics and emergencies. This study evaluated the health- and comfort-based concerns of e-bike (non)users in both pre (PR) and peri (PE) pandemic situations in Sweden.

The trend of using e-bikes is growing rapidly. For example, the trend of worldwide selling shows over 40 million e-bikes was sold in 2015 and the trend keeps increasing (Salmeron-Manzano & Manzano-Agugliaro, 2018). This pattern calls for an in-depth understanding of e-bike users’ concerns. Based on this study, willingness to pay (purchase an e-bike) emerged as an important factor among nonusers. In the PE situation, nonusers used their bikes mostly for short-distance trips, coupled with public transport for long-distance travel. The comfort of e-bike riding was less rendered in the PR situation as purchasing an e-bike requires an initial investment. On the other hand, the convenience of using e-bikes, combined with the health concerns surrounding social interactions when using public transport, simultaneously motivated nonusers to invest in purchasing e-bikes in the PE situation. The results suggest that the financial aids could address nonusers concerns and, eventually, increase in the ridership of e-bikes. There are different attempts by governments across the globe to facilitate the purchase and use of e-bikes. For example, the Swedish government subsidised 25% of e-bike purchase prices in 2018 to support active and sustainable transport modes (Swedish Law -for e-bikes, 2018). On the other hand, in some cases, as shown in this study, nonusers were more interested in renting an e-bike based on their needs rather than purchasing one. This result implies the importance of some additional government policies and programs such as providing and improving e-bike sharing system. There are few studies that explored the concerns and requirements in e-bike sharing policy (Ji et al., 2014). This subject calls for more research in future to provide information regarding the development of this system and evaluate different e-bike facilities. As a result, the LOS studies can be useful to evaluate and improve e-bike infrastructure.

The LOS index is a practical tool that enables planners and decision-makers to evaluate and improve facilities, in this case, cycling facilities (Kazemzadeh et al., 2020a). However, the research concerning e-bike LOS is scarce and an in-depth understanding of e-bike riding comfort provides insight into LOS studies. For instance, the aspects which are retrieved from the user opinion of having e-bike (dis)comfort (e.g., battery performance, riding easiness, and heavy frame), as shown in this study, can be used for developing e-bike LOS research. A realistic picture of e-bike riding comfort facilitates improving infrastructure and may lead to an increase in the modal share of this mode. The improvement of the e-bike mode (in general, active transport mode) contributes to addressing different modern cities’ challenges such as environmental issues, air pollution, and traffic congestion.

Environmental issues caused by motorised modes of transport are of importance, because they trigger societies development towards electromobility. As an example, the transport sector (mostly road transport) is attributed to major proportions of greenhouse gas emissions in Sweden. Consequently, several policies have been discussed and electromobility (e.g., e-bikes) is receiving increased political desire (Hiselius and Svensson, 2014). Simultaneously, the COVID-19 pandemic, the related lockdown policies, and restriction on traveling with motorised vehicles have resulted in air pollution reduction (Hudda et al., 2020). The unprecedented lockdown and its effect on air pollution reduction may trigger policy-makers to adopt different policies to reduce the ridership of motorised vehicles in the post-pandemic situations. E-bikes seem to be a remedy as deemed a reliable mode of transport in the case of PE.

It appears evident that e-bike is a promising substitution for public transport in the PE situation. This too is due to social interaction on public transport and its consequent health concerns. Long-distance trips (over 25 km), which were rarely accomplished by e-bike in the PR situation, were undertaken with the e-bike in the PE situation. A great body of the literature acknowledged the substitution of public transport and car by e-bike (Johnson and Rose, 2015; Plazier, Weitkamp, & van den Berg, 2017). This subject is crucial in the case PE situation as the restrictions on the use of public transport may limit the user’s options. This trend may lead to a substitution in the post-pandemic situation and users’ travel behaviour may change in the PE situation as they adjust to using e-bikes. This pattern is also crucial for future pandemics, when the supply and demand for active transport modes may change. The results suggest that further research is needed for policy-makers and planners to take into account the trend of modal substitution for the post-pandemic situation.
Public transport demand decreased in the case of PE situation due to lockdown and different policies such as the recommendations for the elderly to avoid using public transport. As a result, public transport revenues have decreased and different policies have been proposed around the world to support its revenue losses. For instance, the government of Sweden allocates 3 billion Swedish Kroner to compensate the impact of income reduction of public transport (Tirachini and Cats, 2020). The reduction of public transport ridership implies the importance of understanding the modal shift and adoption of policies to facilitate mobility, especially for those groups who are recommended not to use public transport in the PE situation. The findings of this study regarding the users’ concerns contribute to developing policies in relation to users’ preference and sustain the e-bike mode in the post-pandemic situation.

The trend of substitution raises concerns about e-bike function and performance. Since users rely on their e-bikes for relatively long-distance trips, battery function was a main concern. The heavier frame of the e-bike (compared to bikes) resulted in comfort concerns for users as they may run out of charge on their trips. Also, for short-distance trips, the transport network infrastructure—such as bike racks and bike parking—were the main comfort concerns for users. Since they will be worried about trip-end facilities and the function of their e-bikes, these facts affect users’ comfort. This is not only an important aspect in terms of e-bikes. Infrastructure for cycling is an essential issue for cyclists and has also been critically analysed in previous research (e.g. Cox and Koglin 2020; Koglin and Rye, 2014). The research stream on e-bike comfort and LOS should consider users’ comfort and e-bike function factors when long-distance trips are an indispensable part of the users’ travel plans. The unique user’s concerns related to e-bike riding in PR and PE situations may require to dedicate an exclusive index for each scenario. The developed e-bike LOS indices in the case of PE situation can be useful for the management of future pandemics.

Several factors in this study limit the intended inferences about its results. The relatively limited number of participants in the case of PE situation reduces our ability to generalise the results. Furthermore, the case study considered only residents of Sweden; the results may change in a different context, with different cycling experiences, economic status, and other factors affecting the responses. While this study presents a valuable and simple way to assist cycling planners in making decisions and highlighting the role of e-bikes for (non)users in PR and PE situations, these are preliminary results and further studies are needed. Indeed, the results of this study could be used to provide insights for other world pandemics.

7. Conclusion

This study aims to understand e-bike (non)users health and comfort concerns in the case of PR and PE situations. This study focuses on residents of Sweden, where few studies have been conducted concerning e-bike users’ comfort and health concerns, especially in the case of pandemics. In the PR situation, the provided comfort of e-bike did not encourage nonusers to purchase an e-bike. However, the application of e-bike as a substitute for public transport in the PE situation triggers nonusers to invest in purchasing e-bike. On the other hand, E-bike users agreed concerning physical activity and the health benefits of using e-bikes in the PR and PE situations. Infrastructure facilities and e-bike performance are evident as users’ comfort concerns in the PE situation.

In the PR situation, the explicit application of this mode could prepare planners and policy-makers for future pandemics. In the case of the PE situation—in this case, COVID19—promoting e-bikes and understanding non(users)’ concerns can help to reduce the spread of the virus in transport networks and thus improving public health. The PE situation provided an opportunity for the understanding of e-bike (non)user comfort and health concerns versus their concerns in the PR situation. This study contributes to an exploration of how given the restrictions on social interactions in public transport may lead to changing travel behaviour in post-pandemic situations.

Credit author statement

Khashayar Kazemzadeh: Conceptualization, Methodology, Investigation, Data curation, Writing- Original draft preparation.
Till Koglin: Reviewing and Editing.

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Appendix A. Supplementary data

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