Received: 28 September 2022 | Revised: 24 May 2023 | Accepted: 6 June 2023

DOI: 10.1002/hfm.21002

RESEARCH ARTICLE

WILEY

Gender perspectives on electric micromobility use

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Funding information
Engineering and Physical Sciences Research Council

Abstract

Electric micromobility (e-micromobility) offers the potential to enhance the sustainability of first- and last-mile journeys in urban areas by reducing the number of private vehicle trips. As a new mode of transport, it is imperative that it is not subject to the same male bias that has been evidenced across our existing transport networks. An in-depth qualitative study was conducted with 24 UK participants (12 females) to assess the gender factors that relate to the incentives and barriers of e-micromobility (electric bike and electric scooter) use. Focus groups and interviews were conducted and the data analysis was disaggregated by gender to reveal the differences and similarities between female and male perspectives on e-micromobility use. Differences in the types of trips made and perceptions of fear were prevalent. Key gender-related findings and recommendations are made. By reviewing, and acting upon, the different perspectives that males and females have towards e-micromobility they can be made more inclusive for all. This can enhance their uptake and reduce the dependence on private vehicles.

KEYWORDS

e-bike, e-micromobility, e-scooter, gender, qualitative

1 | INTRODUCTION

Our current transportation systems have been subjected to a historic "default male" bias, which is prevalent across a number of different industries (Criado-Perez, 2019). The ramifications of this within the transport domain have significant safety and social implications. For example, vehicle design and seat belt restraints have historically used only male body measurements which mean that females are more likely to become seriously injured in traffic accidents (Linder & Svedberg, 2019). Male bias in transport planning has prioritized commuter travel behaviors over care work journeys and trip-chaining, which are travel patterns predominantly undertaken by females (Sanchez de Madariaga, 2013). Through published research into these male biases, there has been a recent shift in the need to challenge the male bias within the transport domain (e.g., Gauvin et al., 2020; Madeira-Revell et al., 2021; Mejia-Dorantes, 2019; Ouali et al., 2020; Parnell et al., 2022). This has identified a need for more awareness of the different issues that males and females face when using transportation systems. Importantly, this requires more gender disaggregation when analyzing transport network usage, with the aim to close the gender data gap (Madeira-Revell et al., 2021).

Within the current economic and environmental climate, the transportation sector is facing a demand for radical change to the way that we travel. As transportation is one of the leading sectors contributing to global carbon emissions, there is a requirement for more electric mobility, as well as more active travel within cities (Department for Transport, 2021; IEA, 2022). Private vehicle travel is one of the biggest emitters of greenhouse gases which is why there is a push within sustainability targets for a shift away from private vehicle travel towards more active and sustainable travel options.

Especially for the first- and last-mile journeys which present a real opportunity for reducing our carbon footprint (Kåresdotter et al., 2022). Electric micromobility (e-micromobility) offers an alternative, more sustainable mode of travel for these types of journeys.

E-micromobility is a transport mode that is classified as small and relatively lightweight electric-powered transport that are used for short distance trips and travel at relatively slow speeds (Institute for Transportation & Development Policy, 2019). For the purposes of this work, when we refer to e-micromobility we include electric bikes (e-bikes) and electric scooters (e-scooters). As a notable new mode of transportation that offers much opportunity for reducing the number of private vehicles on the road, increasing access to public transport and encouraging more people to engage in active travel, it is imperative that the inclusivity of e-micromobility is carefully considered. This paper presents work that seeks to help close the gender data gap in the study of e-micromobility through an in depth, qualitative analysis of the incentives and barriers to the use and uptake of both e-scooters and e-bikes. Balanced gender sampling and disaggregation of results by gender will enable the shared and diverging incentives and barriers to e-micromobility use by females and males to become apparent.

1.1 | E-micromobility

Modern e-bikes were first developed in the 1990s and have since undergone technological development to reduce their weight and make them more attractive as a personal travel option. An e-bike has an electric motor that assists the propulsion of the bicycle, yet the user still has to pedal to maintain speed. There are some bicycle-sharing platforms that use e-bikes, where users can use the bike for a single trip before returning it. Private e-bike use is road legal in the UK and has tended to be a more common use of e-bikes, as the widespread implimentation of e–bike shared platforms has only recently been in place. The global sales of e-bikes have increased year on year since they became more commercially available. Within Europe, the number of sales doubled between 2016 and 2019 (Mordor Intelligence, 2020).

E-scooters are a relatively new mode of transport. They were first introduced in the United States in 2017, in Europe they were introduced to France, Spain, Portugal and other cities from 2018 and they also begun being used in some places in Asia and South America from 2019. In the United Kingdom they were introduced slightly later, in 2020, in response to the Covid-19 pandemic which required alternative means of travel to traditional public transport services. As in other countries, an initial trial period was granted in the UK to understand the impact that e-scooters would have on reducing traffic and their integration with existing transport networks. Such trial periods were also introduced in other European countries before being officially rolled out. Within the trial period, only the shared platforms provided by the government's trial scheme are road legal, private e-scooters cannot be used on UK roads. There is, however, some concern over the integration of these modes within our current transport networks (Kobayashi et al., 2019). This research was conducted in the UK during the trial period of e-scooters, so the use of e-scooters refers only to these shared platforms and not personal e-scooters.

1.2 | Gender and e-micromobility

It is important to understand the gender considerations relating to e-micromobility use to ensure that they do not suffer the same default male bias that is found across our current transportation systems (Parnell et al., 2022). Research to date, has considered the gendered use of e-micromobility to some extent with some mixed results. Large-scale survey data has suggested that in countries where cycling rates are high, for example, the Netherlands, Denmark, and Belgium, the number of female users of e-bikes seems to be equal to, or more than, male users (e.g., Haustein & Møller, 2016; Van Cauwenberg et al., 2019). Yet, in countries where cycling is a less popular mode of travel, for example, United States, Australia, and the United Kingdom, males are more predominant users of e-bikes than females (Johnson & Rose, 2013; MacArthur et al., 2014, 2018; Melia & Bartle, 2021). These differences could be due to the different infrastructure provisions for cycling/micromobility within these countries. Initial research into shared electric micromobility platforms such as e-scooters suggests that they are more likely to be used by males (Anapryenka et al., 2022; Dott, 2021; Reck & Axhausen, 2021).

The reasons for the gender imbalance have been considered, with a variety of reasons cited. In relation to e-bike use in the United States, MacArthur et al. (2018) found that the incentives for use were different for males and females, with males more likely to want to use e-bikes for personal errands whereas females saw the value in carrying cargo or children. One of the key reasons limiting female use of e-bikes is similar to their limited use of conventional bikes (e.g., Beecham & Wood, 2014), which is their increased concern for other traffic on the road and dedicated infrastructure (Fyhri & Fearnley, 2015). Females tend to be more safety conscious, which prevents them from feeling comfortable when using micromobility that often do not have adequate infrastructure and this is certainly true for the use of e-scooters (Dott, 2021; Haynes et al., 2019). Price, availability, and reliability have also been cited as factors impacting female's uptake of e-scooters (Dott, 2021). More recent work in Barcelona into e-scooter and micromobility use, including shared cycling platforms, has found important gender differences in the travel patterns of females and males relating to the speed, time of day, and infrastructure use (Cubells et al., 2023). Reviewing the GPS data from e-scooter and cycling facilities across the city, they found that males tended to travel faster on e-scooters and exhibit more risky behavior (Gioldasis et al., 2021). They also found that females were more likely to use micromobility in the afternoon which links to a higher use for nonwork related trips. Females use of bike sharing schemes was significantly lower than males at night, which Cubells et al. (2023) link to the increased risk perceptions of the location of the bike sharing hubs and needing to walk to the locations which females feel less safe doing at night. They also found that females are less likely to use dedicated cycling infrastructure when traveling on shared bikes, especially when the dedicated infrastructure is shared with motorized traffic. The authors link this to the increased potential for harassment from traffic and a lack of confidence in what can be deemed more masculine environments (Cubells et al., 2023; Heim LaFrombois, 2019; Sersli et al., 2022).

While there has been an increased awareness of the demographic factors that may impact the uptake of e-micromobility, there is still relatively little understanding of the gender considerations relating to the use and uptake of e-bikes and e-scooters. Surveys and statistical analyses have been useful to present the figures on the gender split of users, yet these findings need to also be complimented with qualitative insights into the reasons people choose to use, or not use, e-micromobility. In a systematic review of the literature on micromobility shared platforms, Elmashhara et al. (2022) found that qualitative research in this area is scarce and they advocate for more qualitative and mixed methods studies into micromobility to understand the specific behaviors that influence users. Melia and Bartle (2021) conducted a survey on the types of e-bike users in the United Kingdom, which they complimented with more in-depth follow up interviews to identify some of the motivations and barriers to e-bike use. Yet, despite targeted sampling they only had a 30% response from female participants in the survey. Ten interviews were conducted, with six female participants. While there seems to be more of an understanding of the need to understand gender factors, the methods for sampling and analyzing participants by gender is still lacking and suggests that a gender data gap in e–micromobility use could be following similar trends from other transport modes, i.e. a lack of information on female users.

Madeira-Revell et al. (2021) highlight the difficulties in obtaining equal gender samples within transportation research while also presenting the rationale for insisting on disaggregating by gender within the data analysis process to close the gender data gap. There is a gender imbalance within the transportation industry with female workers making up only 22% of workers and in the land transport sector this is even lower at 14% (European Commission, 2021). Furthermore, transportation research is often conducted within engineering sectors which is male dominated and therefore access to females is limited (Madeira-Revell et al., 2021). Pressure to collect data in time-constrained environments also forces equitable sampling to be superseded by deadlines (Madeira-Revell et al., 2021). Unequal representation of males and females within research leads to findings and outputs that become skewed towards more male-centric behaviors and perspectives, that is, the default male bias. This has real safety implications, as highlighted by the vehicle seat safety example, with crash test dummies not representing female body shape and composition (Linder & Svedberg, 2019). Therefore, collecting data on transport use from balanced samples is required to close the gender data gap and enable female transport needs to be held in equal status as male needs. As e-micromobility is a relatively new mode of transport, there is much potential for previous gender gaps that have emerged from our more established travel modes to be closed by collecting data on females, to make future travel options more equitable.

Through a scoping review, key factors that influence how gender relates to the use of our more established transport modes have been identified (Parnell et al., 2022). This scoping review included literature looking into gender across road, rail, aviation, and maritime modalities. This review resulted in a set of factors and subfactors that provide an understanding of the different ways in which gender impacts on transport use and the experience of travel. The scoping review included cycling and pedestrian literature, but it did not investigate e-micromobility. This paper therefore seeks to understand how the gender factors evident within more established transport modes relate to newer modes of e-micromobility travel. In doing so it hopes to identify any possible gender gaps and provide recommendations that can ensure this new modality is more equitable than previous transport modes.

This paper will review the incentives and barriers to the use of e-micromobility modes, including both e-scooters and e-bikes. It will review the gender factors identified in Parnell et al. (2022) to identify how the gender factors from other transport modes relate to these new modes of travel. These gender factors are presented in Table 1. This work will seek to understand if the gender factors continue to be prevalent in the use and uptake of these new travel modes, as well identifying areas where e-micromobility can be made more gender equitable. We therefore pose two research questions:

1) How do the gender factors identified from more established transport modes relate to e-micromobility use?
2) Are there any differences in how the gender factors are reported by males and females in relation to e-micromobility use?

Through ensuring a balanced and gender equal sample and disaggregating the data by gender, we aim to help close the gender gap in e-micromobility research by understanding the perspectives of both males and females in the United Kingdom.

This paper presents the methodology used to collect data from focus groups and interviews in the following sections, including the sample and their demographics (Section 2.1). A detailed overview of the procedure is given in Section 2.3. The qualitative data analysis method is then presented in Section 2.4, including the inter-rater reliability metrics. A discussion of the results in relation to the gender factors shown in Table 1, presents the participants' incentives and barriers to e-micromobility use.

2 | METHOD

Data was collected from two focus groups and 14 online interviews with a total of 24 participants. To be as inclusive as possible, the research was collected through an in-person focus group, an online focus group, and online interviews to enable participants to take part at their convenience. This enabled a broad range of participants and

TABLE 1 Gender factors and subfactors identified for current transport modes in Parnell et al. (2022).

Top-level factors		Subfactors	
Family and Community Roles	Gender impacts on the different roles that individuals have within the family and the community. These often relate to caregiving and domestic work which can impact the mode of transport used between genders.	Dependants	A person who relies on another for full-time care, support, and finance.
		Division of Work	The allocation of domestic work and caring responsibilities.
Safety and Perceived Safety	Gender impacts on how safe and secure individuals feel when traveling on different transport modes which can lead to different travel choices being made.	Time of Day	Night-time, daytime, on-peak, off-peak.
		Personal Safety/ Harassment	Risk of harm from the environment and others around, including unwanted behaviors and abuse.
		Fear	Threatening experiences in response to possible harmful and dangerous situations
Ergonomic Standards	Gender impacts on ergonometric measurements which are used to accommodate passengers and ensure their safety.	Injury Risk	The risk of inflicting harm upon a person
		Female Body Shape	The physical properties of the female body which differ to male bodies in their size and composition.
Mobility Needs	Gender impacts on the different needs that individuals may have while traveling due to the different types of trips made.	Facilities	Availability of resources and amenities that would be required to assist everyday life.
		Trip Characteristics	The features of a journey that influence how it is conducted, its purpose and objectives
User Behavior	Gender impacts on the behaviors of individuals, including their perceptions and requirements for systems to perform in certain ways.	Behavioral Trends	Tendencies for certain behaviors, often relating to social and cultural norms
		Wellbeing	The psychological state in relation to comfort, happiness and stress
Urban Structures	Gender impacts on the requirements that individuals have for the design of transport infrastructure and how they interact with it.	Encumbered Travel	The presence of objects that limit the ability to move freely.
		Infrastructure	The physical and organizational structures that comprise an environment.

allowed for an equal gender split, as often females can find it difficult to participate in in-person research e.g., due to increased un-paid care duties (Madeira-Revell et al., 2021). Figure 1 provides a data flow chart that shows the steps involved in this research study with an explanation of each stage.

2.1 | Participants

2.1.1 | Focus groups

Two focus groups were run. Focus group 1 was conducted in-person and included six participants (three females) and their average age was 44.33 years (range: 22–68 years, SD: 19.02 years). Focus group 2 was conducted online and included four participants (two females) and their average age was 47.75 years (range: 39–59 years, SD: 9.43 years). Demographic information for the focus group participants is provided in Table 2.

2.1.2 | Interviews

Fourteen online interviews were conducted with an equal gender split in participants. Participants of different genders were matched on age, with the seven females having an average age of 47.71 years (range: 31–62 years, SD: 10.50 years) and seven males averaging 44.43 years (range: 26–65 years, SD: 15.72 years). Further demographic information for the interview participants is also presented in Table 2.

The gender split across the use of e-scooters and e-bikes is shown in Table 3. Prospective users were classified as those who do not currently use the travel mode but are interested in doing so in the future. The nonuser category included those who were not willing to use the mode of transport, or cannot for other reasons (e.g., health limitations). Unfortunately we were not able to discriminate between these types of nonusers within this data set. There were 12 participants (seven female) who did not use e-scooters or did not want to use e-scooters and only two participants who did not or did

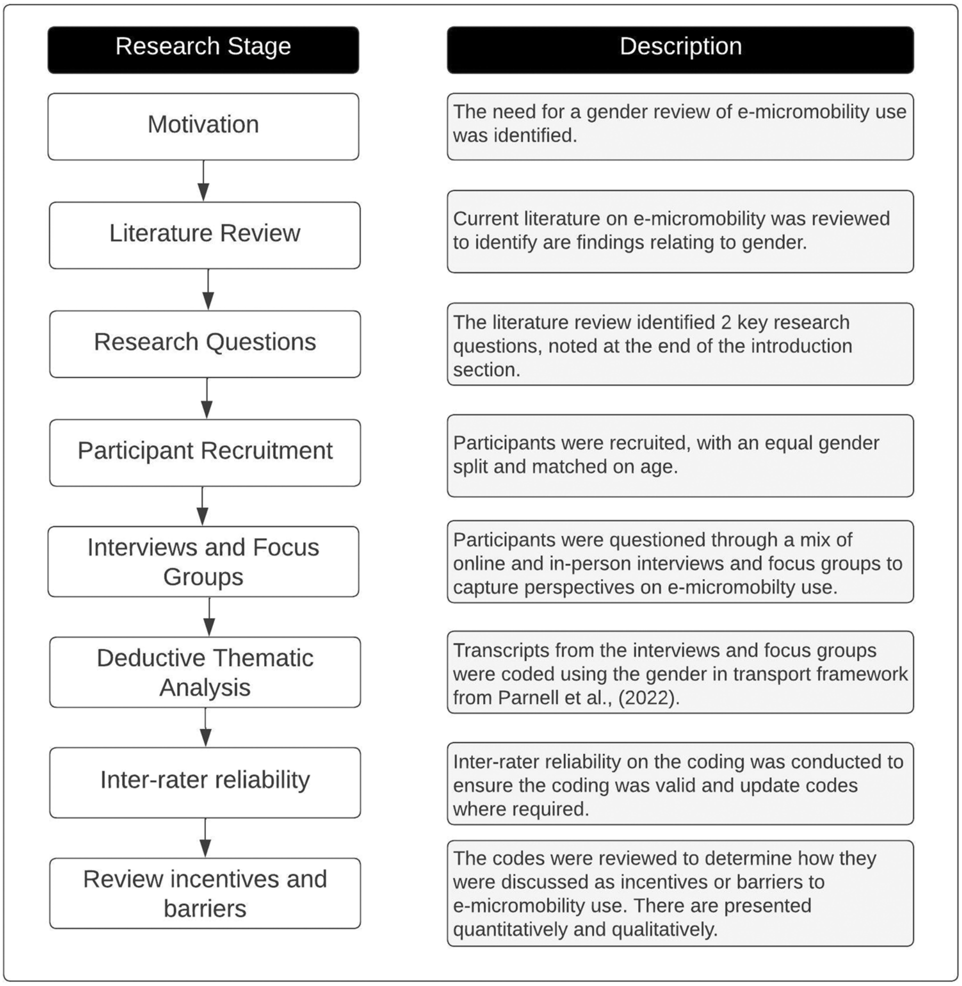

FIGURE 1 Data flow diagram of the stages involved in the research study.

TABLE 2 Demographic information for focus group and interview participants.

Demographics	Focus group 1	Focus group 2	Interview
Study format	In-person	Online	Online
Females (*n*)	3	2	7
Males (*n*)	3	2	7
Average age (years)	44.33	47.75	45.1
Age range (years)	22–68	39–59	26–65
Car owners (*n*)	4	2	10
Full time employment (*n*)	3	4	9
Student (*n*)	3	0	0
Part time employment (*n*)	0	0	5
Live with dependants (*n*)	1	3	6

not want to use e-bikes. The nonusers of e-bikes were both male and this was due to them preferring to use traditional bicycles instead of electric bicycles. The sample did not include any female users of e-scooters; this may be due to the reduced number of female users that has been reported in the literature (Anapryenka et al., 2022; Dott, 2021; Reck & Axhausen, 2021). There were nine prospective e-scooter users, that is, those who were interested in using e-scooters in the future (five female). There were seven female participants and four males participants who were interested in using e-bikes in the future (prospective e-bike users). There was a similar number of male ($n = 6$) and female ($n = 5$) current users of e-bikes. All these users had their own e-bikes.

N.B. Participants could be a current user of e-bikes and e-scooters, a user of one mode and a prospective/nonuser of the other mode or a prospective/nonuser of both transport modes. As such, the totals add up to 48 to account for the use of 24 participants across the two modalities.

TABLE 3 Participant use of e-bikes and e-scooters by gender.

	Current e-bike user	Current e-scooter user	Prospective e-bike user	Prospective e-scooter user	Non-e-bike user	Non-e-scooter user
Male (*n*)	6	3	4	4	2	5
Female (*n*)	5	0	7	5	0	7
Total	11	3	11	9	2	12

TABLE 4 Interview and Focus group questions.

Question focus	Prompts
Users of e-micromobility – For those that currently use e-bikes and/or e-scooters	1. What *journey types* do you use e-micromobility for? 2. What *type of transport* did you previously use for these journeys? 3. What initially *motivated* you to use e-micromobility platforms?
Prospective/nonusers of e-micromobility – For those who do not use or would like to use in the future	1. What *types of e-micromobility* would you like to use? 2. What *types of journeys* would you like to use the e-micromobility for? 3. What is currently *preventing* you from using e-micromobility?
Societal impacts – Focusing on the broader use of e-micromobility, not just personal use	1. What do you see as the main *benefits* of using e-micromobility platforms? 2. What do you see as the main *barriers* to using e-micromobility platforms? 3. What journeys would you *not* use e-micromobility platforms for?

Note: These questions were applied in both the focus groups and interviews, within the focus groups users of each mode were asked to contribute to the relevant questions and in the interviews only the sections relevant to the individuals use were asked depending on their use of each mode.

2.2 | Procedure

2.2.1 | Focus group procedure

Focus group 1 was run in person, with all attendees sitting in the same room with the researchers for the discussion. Focus group 2 was run online using Microsoft Teams, due to last minute external circumstances which prevented everyone from being able to attend in person. The same PowerPoint presentation with the questions for discussion was presented to both focus groups. Participants were reminded that the group was a safe space to share opinions and behaviors, allowing people to take their turns in speaking. The lead author facilitated the session, ensuring all participants were heard and had an opportunity to speak. Both focus groups sessions ran for 1 h. For the in-person focus group, participants received cash payment of £10 for their time, while the online focus group received an online voucher for the same amount.

2.2.2 | Interview procedure

All interviews were run online to allow flexibility and convenience when recruiting, enabling a matched and equitable sample. The interviews were run on Microsoft Teams with the participant and the researchers. The researchers presented the same PowerPoint presentation as in the focus groups with the key questions within the online meeting so that the participant could follow them easily. All interviews were audio recorded and transcribed. The Microsoft Stream transcription was used as a starting point and then the researchers reviewed the recording and updated and amended the transcription for accuracy and fluency. The interviews lasted around 20–30 min per person.

2.3 | Materials

A PowerPoint presentation was presented in both the focus groups and interviews which introduced the researchers, the wider project, and the aim of the session (i.e., to understand the incentives and barriers to e-micromobility use). Participants were not made aware that the purpose of the research was to review gender specifically, as the gender factors were only reviewed at the analysis stage. The questions posed to the participants in both settings are presented in Table 4. Further scenarios were proposed to participants at the end of the interviews and focus groups, but these are out of the scope of this paper and therefore only the responses to the questions in Table 4 were analyzed for the purpose of this paper.

2.4 | Data analysis

The transcripts from the focus groups and interviews were coded for the incentives and barriers that participants' discussed. Incentives for using e-bikes and/or e-scooters included all comments on the motivating reasons for using them, ways that they would like to use them and the benefits that they may bring. Barriers for using e-bikes and/or e-scooters included all comments relating to the limitations in their use and the reasons that prevented them from being used. These were reviewed from the responses to each of the questions in Table 4.

The transcripts were then further coded deductively using the gender factors and subfactors in transportation presented in Table 1 (see Parnell et al. (2022) for more information on how these were developed). The factors that relate to the incentives and barriers to e-micromobility use could then be identified. They could also be disaggregated by gender through matching the transcripts to the demographic details provided by the participants.

An inter-rater reliability assessment was conducted to determine the reliability of the coding performed by the primary researcher of the gender factors. 10% of the coded transcripts were given to two researchers with experience in deductive thematic analysis and a total of 17 years of experience in transportation research and qualitative research. The percentage agreement of the inter-raters was calculated. Rater 1 had an initial agreement of 60% for both the high-level gender factors and the subfactors. Rater 2 had an initial agreement of 75% for the top-level gender factors and 40% for the subfactors. A review meeting was held with both raters to clarify and discuss the coding scheme. Adjustments to the definitions of the factors were made and the difference between the subfactors of 'encumbered travel' and 'dependants' was clarified as this was the cause of a high proportion of the disagreement score. The agreement following this increased to 80% for rater 1 for both high-level factors and subfactors. Rater 2 agreement increased to 90% for the high-level factors and 75% for the subfactors This is above the acceptable level of agreement of >75% (Norcini, 1999).

3 | RESULTS

Analysis of the questions posed in the interviews and focus groups in relation to the gender factors (Parnell et al., 2022) that influence the incentives and barriers to the use of e-micromobility are presented.

3.1 | Incentives and barriers to using e-micromobility

The number of references to each of the gender factors was calculated following the deductive coding and inter-rater reliability analysis. Those coded as incentives and as barriers were compared for both e-bikes and e-scooters, disaggregated by gender. See Table 5 for the figures, with the shading corresponding to the number of references that were coded (darker represents a higher number of coded references to the factor). The numbers reflect individual references, not necessarily individual participants. Some participants made more than one reference to the same factor, but from a different perspective or angle and these were cited as separate references in the totals in Table 5, as well as Figures 2 and 3. There were more references to the barriers compared with the incentives, particularly in relation to e-scooter use. However, this should be

TABLE 5 Number of cited gender factors for both e-bikes and e-scooters across the interviews and focus groups.

Gender factor		E-bike				E-scooter			
		Female incentives	Male incentives	Female barriers	Male barriers	Female incentives	Male incentives	Female barriers	Male barriers
Family and Community Roles	Dependants	1	-	2	-	-	-	2	-
	Division of Work	3	-	-	-	-	-	-	-
Safety and Perceived Safety	Time of day	-	-	1	-	-	-	2	3
	Personal Safety	-	-	-	1	-	1	13	11
	Fear	-	-	1	-	-	-	8	-
Ergonomic Standards	Injury Risk	-	-	-	-	-	-	1	-
	Female Body Shape	-	-	1	-	-	-	-	-
Mobility Needs	Facilities	1	-	-	1	-	1	-	-
	Trip Characteristics	2	3	3	6	4	8	2	8
User Behavior	Behavioral Trends	2	2	-	1	-	3	3	8
	Wellbeing	2	1	-	2	2	1	-	-
Urban Structures	Encumbered Travel	1	-	1	1	-	1	5	1
	Infrastructure	2	2	5	3	3	2	5	9

Note: Shading reflects the number of coded references (black high, white low).

considered in relation to the participant usage figures in Table 3, with a higher number of participants being nonusers of e-scooters, particularly female participants. It should be noted, however, that the references to the incentives and barriers for e-bikes and e-scooters were coded across all participants, irrespective of their current usage patterns. This is because some prospective and nonusers of e-micromobility still considered the possible incentives to their use, alongside the barriers and current users also mentioned possible barriers.

The aggregated e-bike and e-scooter figures are presented visually in Figure 2 to show the total number of subfactors that were coded as incentives to e-micromobility use. The same for the barriers to e-micromobility use is shown in Figure 3. The figures show the difference between males and females in the types and number of references made to the transport gender subfactors.

Figure 2 shows that Trip Characteristics was the most cited factor when participants discussed their incentives to use e-micromobility. This was true for both male and female participants, although more references to this factor were made by males ($n = 11$) than females ($n = 6$). The User Behavior factors, Behavioral Trends, and Wellbeing were also mentioned frequently as incentives. Males cited the Behavioral Trends subfactor more frequently as an incentive ($n = 5$) than females ($n = 2$), whereas females cited Wellbeing more frequently (males, $n = 4$; females, $n = 2$). Neither of the Ergonometric Standards subfactors were referenced as incentives, by either males or females. The only reference to Safety was by one male participant who referenced Personal Safety as an incentive for e-scooter use. No males cited Family and Community Roles as an incentive, yet there were four references by female participants, one for dependants and three for division of work. Finally, Urban Structures was also mentioned as an incentive by both genders, with a number of comments relating to infrastructure as a possible incentive for e-micromobility use (females $n = 5$, males $n = 4$). However, when reviewing the barriers in Figure 3 there were notably more barriers associated with the infrastructure subfactor.

Figure 3 shows the barriers to e-micromobility use by males and females. Infrastructure, Trip Characteristics, and Personal Safety appear to be the common barriers for both males and females, albeit with some variances. Males cited Trip Characteristics as the most frequent barrier to using e-micromobility ($n = 14$), whereas females cited this factor to a lesser degree ($n = 5$). For females the more significant barrier was Personal Safety ($n = 13$), and males also cited this to be quite a significant barrier with 12 references. Females also frequently stated the subfactor Fear ($n = 9$), whereas males made no reference to this factor as a barrier to e-micromobility use. Time of Day was equally mentioned by males and females ($n = 3$) as a Safety related barrier. Females cited Dependants as a barrier four times, yet no mention of the Family and Community Roles subfactors were mentioned as a barrier by male participants. The Ergonometric Standards subfactors, Injury Risk and Female Body Shape, were mentioned once each as a barrier by female participants. Male participants mentioned User Behavior subfactors more frequently than female participants. Male cited nine instances of Behavioral Trends as a barrier, whereas females only cited 3. Wellbeing was also cited by male participants twice, with no females citing this as a barrier. Both of the Urban Structures subfactors were frequently

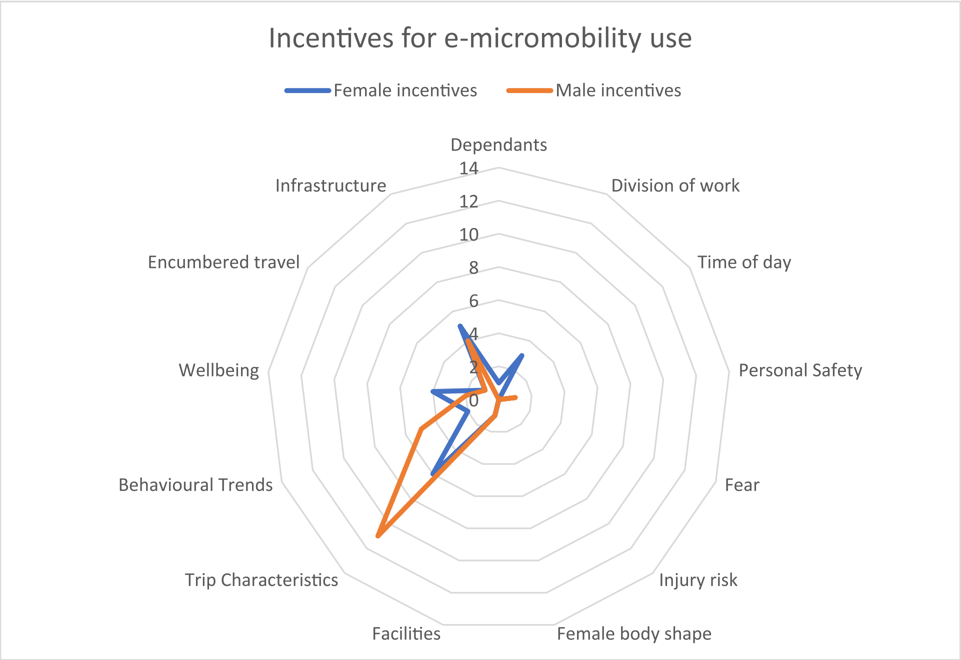

FIGURE 2 Gender subfactors relating to the incentives for using e-micromobility for males and females.

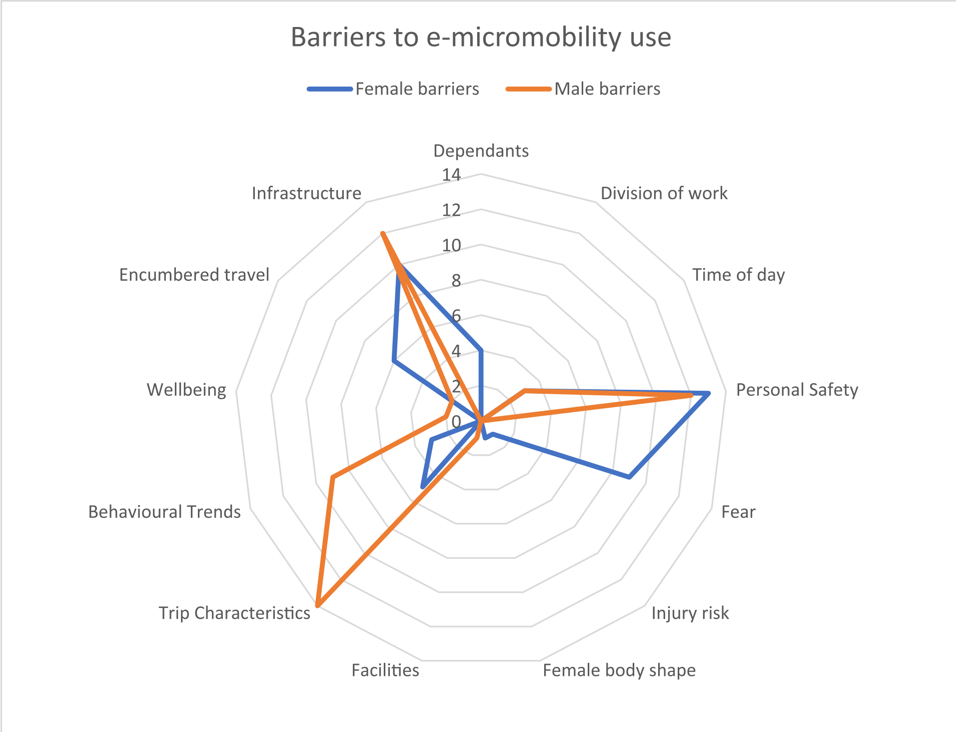

FIGURE 3 Gender subfactors relating to the barriers to using e-micromobility for males and females.

cited by participants, who found the Infrastructure to be a significant barrier (males, $n = 12$; females, $n = 10$). Encumbered Travel was stated more frequently as a barrier by females ($n = 6$) than males ($n = 2$).

4 | DISCUSSION

Focus groups and online interviews were conducted with a sample of 24 participants, comprising an equal split of males and females. Questions relating to the incentives and barriers to the use of e-bikes and e-scooters were posed and these were then reviewed to understand if there were any prevalent gender factors in the perceptions and use of e-micromobility travel modes. Deductive thematic qualitative coding was conducted on the results, using the gender factors identified in Parnell et al. (2022) as the thematic framework. Disaggregation of this analysis by gender has enabled the comparison of males and females on their views of e-micromobility use to help close the gender data gap within this transport domain.

4.1 | Gender factors in e-micromobility use

As shown in Figures 2 and 3 there were some similar and dissimilar trends across males and females in the frequency of references to the different gender factors as incentives and barriers to e-micromobility use. The findings in relation to each of the gender factors in transportation, as outlined in Parnell et al. (2022) are discussed below.

4.1.1 | Family and community roles

Males made no references to either of the Family and Community Roles subfactors (Dependants and Division of work) while they were cited by females as both incentives and barriers. The incentives cited by females were in relation to e-bike use and predominantly refer to the ease with which they can be used to escort children to school, for example, “I didn't need to drive him to nursery anymore. So at that point I got an e-bike and I was using it, taking him to and from school and me to and from university through to the winter” (P2). One female participant was the owner of an e-cargo bike and she was very positive on its utility for being able to transport her two children easily. However, females also stated how Family and Community roles, particularly Dependants, act as barriers to the use of both e-bikes and e-scooters. With e-scooters the limited ability to be able to travel with small children was highlighted, for example, “it's that lack of tandem options or taking into account people with younger children who you know aren't used to it and can't be strapped into something” (P13).

Clearly females are more minded of the Family and Community Roles that relate to the use of e-micromobility. More of a focus on the utility in e-micromobility for escorting children was also found by MacArthur et al. (2018). As females typically play the predominant caregiver role, the types of journeys that they make may not be compatible for the use of e-scooters, where small children cannot easily be accompanied. As a replacement for walking, they are therefore limited in their use by females and/or those in primary caregiving roles. However, those participants who used e-bikes to accompany small children did find ways to utilize them on the school run e.g. by cycling with their child or carrying them on a cargo bike. MacArthur et al. (2018) also identified that females were more likely than males to say they would like to use cargo bikes to carry children.

4.1.2 | Safety and perceived safety

Safety was a very important factor within the focus group and interview discussions. This echoes the concerns for the safety of micromobility on the roads (Cicchino et al., 2021; Kobayashi et al., 2019). Some Safety incentives were found for e-micromobility, with one male participant highlighting the reduced number of incidents that may occur with less cars on the road. Yet, Safety was predominantly a barrier to the use of e-micromobility, specifically e-scooter use with 23 individual references by females across each of the three Safety subfactors and 14 references by males. Personal Safety was the most cited subfactor with both males and females claiming that they would not feel safe traveling on an e-scooter on the roads. For example, "I have concerns about the safety of scooters themselves in terms of breaking…vulnerability to cars is always an issue using these small vehicles" (P11, male). There was also the view that e-scooters are riskier than cycling, for example, "I think they appear to be a bit riskier than cycling, but it might be the way that they're used" (P16, female). As well as the Personal Safety subfactor being the more frequently cited barrier for females (this was not true of males), the Fear subfactor was also frequently mentioned by females for e-scooter use, but it was not referred to by any male participants. While males tended to reference the lack of safety protocol, they did not mention that they would have a fear or fearful emotions towards using the transport modes, whereas females talked more frequently about a "lack of confidence" (P1 female) and being "anxious" (P18, female), and a "nerve wracking experience" (P17, female). This echoes the findings that females tend to have a higher risk perception than males which impacts on their likelihood to cycle (Beecham & Wood, 2014; Frings et al., 2012; Prati et al., 2019). In a review of the social discourse relating to active travel, Haynes et al. (2019) identified that females were more like to discuss their internal subjective feelings of feeling unsafe, whereas males gave more objective descriptions of the safety of the road. This may explain the distinction made between the two subfactors "Fear" and "Personal Safety" and why females made more fear citations. The fear that females describe needs to the fully understood it appears to be a significant barrier to their use of e-micromobility.

The Time of Day subfactor was equally mentioned by male and female participants, notably these comments related to not feeling safe using e-micromobility at night. In contrast to other modes of travel such as walking where time of day can lead to females being fearful of harassment (Schmucki, 2012), most of the comments around time of day related to reduced visibility. It was highlighted by males and females that e-scooters were particularly poorly lit and that users may not generally carry lights or reflective clothing with them.

4.1.3 | Ergonomic standards

There were only two references to Ergonomic Standards subfactors, one each to Injury Risk and Female Body Shape, both of which were referenced by female participants. Ultimately there were no real mentions of the size of e-bikes and e-scooters and how this may influence their use and uptake. The public e-scooters available in the United Kingdom are a one-size-fits all approach and while no participant mentioned if this sizing is adequate for male and female body sizes, this could be an important area to look into. Siebert et al. (2021) conducted a survey of German e-scooter users and reviewed the ergonomics of the brake-system, however the sample had a male bias with 107 males and only 46 females, perpetuating the gender data gap. They stated that there was a clear difference in preference for a left-hand brake, yet as this not based on an equal sample size of males and females, it cannot be said that this is true for females. Furthermore, they also stated that one-third of participants could not correctly identify the braking system of the last e-scooter platform that they rode. Research by Cubells et al. (2023) found that males were more likely to ride e-scooters at higher speeds and more aggressively, therefore the use of brakes by males and females is likely to differ. As such, equal gender sample sizes and gender disaggregation is important here. More research is needed to review the gender equity in e-scooter ergonomics. Within bike design there is an already acknowledged male bias within conventional bikes (Potter et al., 2008). Although more knowledge of the differing body size and compositions is now informing bike design, this should be focused on within e-bike design also.

4.1.4 | Mobility needs

The Mobility Needs factor includes Facilities and Trip Characteristics. Facilities was discussed to a limited extent. In relation to e-bikes, incentives, and barriers related to the storage of e-bikes at the desired destination. Statements that were coded to Trip Characteristics included where features of a trip influence how e-micromobility could be used. Trip Characteristics was both the most frequently cited incentive and most frequently cited barrier for male participants. The diverse opportunity for e-micromobility travel may be the reason for this factor being both an incentive and a barrier, depending on the type of trip being undertaken. The incentives that males stated for Trip Characteristics related to the utility of e-micromobility for short-medium journeys, for example, "they're very good at bridging that gap between too long to walk and too short to drive, they're perfect for that like 5-mile radius I would say because you can get an e-scooter and go there" (P24, male) and they valued being able to "leave them [e-scooters] wherever you finish your journey" (P11, male). Conversely, Trip Characteristics that were seen as a barrier related to concerns over whether the battery would last long enough and comments on range anxiety for longer journeys, for example, "I don't think the batteries last long enough or the distance that they can go would be long enough" (P19, male). Females, however, were less concerned with the battery but said a range of other Trip Characteristics which could be barrier to their use including poor weather conditions, limited access, and off-peak times.

Broadly, research into the use of e-bikes has found that males and females use them for similar types of trips and purposes (Haustein & Møller, 2016; MacArthur et al., 2018; Melia & Bartle, 2021). However, typically females undertake more trip chaining activities whereas male travel patterns are more likely to be into and out of large transport hubs (Scheiner & Holz-Rau, 2017). The utility that males cited in relation to being able to access other modes of transport via e-micromobility suggests that they benefit from going to these larger hubs where e-micromobility is well provided for. The barriers to e-micromobility use that the female participants cited were similar to those identified by e-scooter provider Dott (2021) who cite trip-chaining, reliability, and availability as key factors impacting the reduced use of e-scooters by females. Closer consideration of the locations of the e-scooter hubs in relation to Trip Characteristics should be considered.

4.1.5 | User behavior

User Behavior was another factor that was frequently mentioned as both an incentive and a barrier to e-micromobility use. Males referenced the Behavioral Trends subfactor more frequently as a barrier than females, but both referred to it more with respect to e-scooters. Both males and females highlighted the difficulty in initially understanding how to use e-scooters and the use of new technology being an issue. Other Behavioral Trends that were cited as barriers included "laziness" (P19, male), "feeling daft" (P23, male) and "forgetting to charge it" (P14, male). Incentives relating to Behavioural Trends included the shift towards being outside more, for example, "me and my family have found that actually we go out more in, in bad weather…and actually it is brilliant" (P17, female) and preferring to be outside rather than using the bus. These comments support similar findings identified in e-bike use by Melia and Bartle (2021).

The Wellbeing subfactor was coded to comments made on the enjoyment and connections to nature that e-micromobility offers. These were more frequently mentioned as incentives by females, for example, "there's this really nice connect with nature because one of the things I really like about cycling is that you realize that there are leaves in the gutter and it's slippy and, but you look at the colors of it and you see the changing seasons and you feel it more, and actually that's quite nice and I really enjoy it, and the children really enjoy it as well" (P17, female). Taken in combination with the other comments on increased fear and safety concerns, there is some opportunity to capitalize on the positive elements and enhanced wellbeing that e-micromobility may bring, once the safety is more established. Further research should look at exploring the balance of enjoyment and safety concerns within e-micromobility.

4.1.6 | Urban structures

The subfactors of Urban Structures were again referenced as both incentives and barriers, but the barriers were much more frequent, for both males and females. Encumbered Travel was coded to aspects where participants discussed traveling with baggage. This is adapted somewhat from the original link to Urban Structures which related to the use of pavements and roadways when traveling with shopping or pushchairs (Parnell et al., 2022). So, while it may not seem relevant to the high-level factor within e-micromobility travel we have kept it here for consistency, but this point was noted within the coding process and is amended in the key findings in Table 6. Females particularly cited Encumbered Travel as a barrier to using e-micromobility, more so than males. The difference between e-scooters and e-bikes was prevalent, for example, one participant stated "Obviously, if you're carrying anything like lots of shopping, you wouldn't use it [e-scooter] for that, whereas on my bike I've got my panniers" (P16, female). Previous research has suggested that females are more likely to be traveling encumbered (Transport for London, 2019) and taking journeys where they may need to be carrying additional luggage (Dickinson et al., 2003). The limitations of e-scooters for shopping journeys, more typically undertaken by females, were evident "so I tend to, you know, do like all of my shopping at once, but go to multiple places. So I wouldn't use it for that" (P18, female). For more gender equitable use there is a need for e-scooter fleets with baskets (Campisi et al., 2021).

Infrastructure was a heavily discussed subfactor, which was predominantly seen as a barrier to e-micromobility use by both males and females. There was some discussions of Infrastructure as an incentive; these comments focused on the benefits of more e-micromobility on the road and the replacement of cars, for example, "minimizing the number of traffic jams and just generally creating a better flow around the city" (P18, female). The barriers, however, heavily cited the lack of proper Infrastructure for cyclists and scooter users. This included concern over e-scooters using pavements, for example, "I'm quite concerned about the way some people ride on e-scooters going on the pavements and and people both on e-scooters and bikes, ignoring traffic lights and things like that" (P1, female). The uncertainty on where e-scooters should be used was also prevalent, for example, "I've seen people at traffic lights and things like that and it's they're definitely seems to be some confusion of whether the scooters should be on the road in the first place, what their positioning on the road should be" (P24, male). The lack of cycle lanes was also cited as key barrier for e-bike use.

The large number of concerns surrounding the road infrastructure support many other claims in the literature that infrastructure is significant barrier to e-micromobility use, especially in females (Anapryenka et al., 2022; Bliss, 2019; Melia & Bartle, 2021). However, it was evident from this work that males are equally concerned about the road layout when using e-bikes and e-scooters. Therefore, improvements to the road infrastructure for e-bikes and e-scooters will benefit both male and female users, making them more accessible to all.

TABLE 6 Key findings and recommendations for each of the gender factors and subfactors.

Gender factor		Key findings and recommendations
Family and Community Roles	Dependants	• Females are more concerned with how they can travel with children. Males are less likely to discuss this factor in relation to e-micromobility use. • E-scooters offer the opportunity to escort children e.g. when they are on bikes. Yet the infrastructure can make this difficult. E-bikes with tandem or cargo attachments are seen as an attractive option to females.
	Division of Work	• The types of trips that females make e.g. to school, escorting children, care work, shopping, are currently less practical to use e-micromobility for. Walking offers a more accessible option.
Safety and Perceived Sfety	Time of Day	• Males and females are concerned about the use of e-micromobility at night due to the limited visibility. • Adequate lighting for e-scooters would benefit males and females.
	Personal Safety/Harassment	• Personal safety is a significant concern for males and females, particularly for e-scooter use. For females it was the most mentioned factor, suggesting it is one of the biggest barriers. • There was, however, no real discussion on the possibility for harassment when traveling by e-micromobility.
	Fear	• Fear was an emotion described only by females, males did not mention feeling fear. They talked more objectively of the risk factors related to safety.
Ergonomic Standards	Injury Risk	• Injury risk from the ergonomics of e-micromobility was discussed very limitedly. It was only mentioned by one female participant who stated the risk to wrists when falling off e-scooters.
	Female Body Shape	• More gender disaggregated data is required to understand the ergonomic constraints of e-micromobility relative to male and female body shapes.
Mobility Needs	Facilities	• Provision of storage facilities at destinations is a key factor in incentivising e-bike travel. The increased cost of personal e-bikes mean that they require safe storage, more so than conventional bikes. These are more likely to be found at places of work, but not in town centers.
	Trip Characteristics	• The characteristics of a trip are a key factor in the use of e-micromobility by males. They are incentivised by the ease of use. Yet, the battery life and range anxiety can put them off using them for some journeys. • Conversely females undertake a wide variety of journey types which prevent them from using e-micromobility.
	Encumbered Travel[a]	• Females are particularly limited in their use of e-micromobility due to performing encumbered travel quite frequently. • The development of a basket for bag storage may increase the use of e-scooter uptake, for females and males. • E-bikes offer more opportunity for storage. Many users have panniers to carry baggage, which increases the types of journeys that they can use their e-bike for.
User Behavior	Behavioural Trends	• A lack of understanding on how to access and use e-scooters is a barrier for both males and females. • Regular users of e-micromobility are generally enthusiastic and positive about the change in behavior that e-micromobility has facilitated.
	Wellbeing	• Females are more likely to be incentivised by the benefits to their wellbeing that e-micromobility can bring. This includes more of a connection to nature. • Overcoming feelings of fear and placing value in wellbeing could be a way of increasing female uptake in e-micromobility
Urban Structures	Infrastructure	• A lack of usable infrastructure was a significant barrier to the use of e-micromobility, for both males and females. • Increasing the micromobility infrastructure will motivate more people to use e-micromobility. This will also link to improved safety perceptions of the travel mode.

[a]Encumbered Travel has been moved from Urban Structures, as presented in Table 1, to sit within the top-level "Mobility Needs" factor to reflect the discussions made by participants for this subfactor.

A summary of the key findings and recommendations for future research are proposed in Table 6. This brings together the findings within this research as well as those that support other research within the field. These recommendations are wide in scope and target a number of different actors and positions of responsibility within the e-micromobility domain. Within our future work we will aim to identify how to enact these recommendations as well as collect further data to establish the relative importance and achievability of these recommendations.

5 | LIMITATIONS AND FUTURE WORK

There were some limitations to the study relating to the sample of participants. Despite efforts to collect and equal sample of males and females, the method of recruitment required participants to respond to a study advertisement asking for their views on e-micromobility, therefore the sample was biased towards those who were interested in e-micromobility. This included those who were very positive about their use of e-micromobility as well as those who wished to voice their negative views towards it. Furthermore, within the assessment of users, prospective users and nonusers, we did not discriminate between those who did not want to use e-micromobility and those who could not use e-micromobility due to health conditions, due to anonymity in the small sample size. There are however numerous inclusivity issues and health conditions that may limit access to e-micromobility which should be looked into within future work. We were also unable to have an equal number of current, prospective, and nonusers of e-micromobility or an equal number of male and females across these three categories. This could be due to the fact that e-micromobility is a relatively new transport mode, the sampling method and the small sample size. We wish to address these limitations with a larger sample size and an online survey within future work. Following this work we anticipate further research into the wider systemic influences of e-micromobility use through the application of sociotechnical systems methods. This will aim to review the wider environmental, regulatory and political considerations in relation the recommendations made within this work.

6 | CONCLUSION

This paper has provided an insight in how the gender factors that are evident within traditional transport modes (including road, rail, air, and sea), relate to the relatively new modes of e-micromobility. An equal sample size of males and females enabled disaggregation by gender within the analysis and the similarities and differences within the perspectives of males and females were presented. Females were more concerned with the impact that e-micromobility has on conducting family and community roles. Males tended to be heavily incentivised by the characteristics of the type of trip that they are taking when choosing to use e-micromobility. While males and females were concerned with the safety of using e-bikes, and especially e-scooters, females were much more likely to equate this to feelings of fear which prevented them from using e-micromobility. Supporting other research within the field we recommend the implementation of improved road infrastructure to increase the uptake of e-micromobility, for both male and females. We also propose key findings and recommendations in line with the gender factors inherent within our existing transport systems, to prevent the male bias from continuing with the development of new travel modes.

ACKNOWLEDGMENTS

We are grateful for support from the Decarbonising Transport through Electrification (DTE), A whole system approach Network+ funded by EPSRC grant reference EP/S032053/1. With thanks to the support of the Close the Gender Data Gap group (http://closethedatagap.soton.ac.uk/).

DATA AVAILABILITY STATEMENT

Research data are not shared.

ETHICS STATEMENT

The data collected in this research was approved by the University of Southampton Ethics Board. REF: ERGO 69348

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How to cite this article: Parnell, K. J., Merriman, S. E., & Plant, K. L. (2023). Gender perspectives on electric micromobility use. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 1–14. https://doi.org/10.1002/hfm.21002