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Are fast e-bikes an alternative to motorised individual transport? An exploratory study in Lausanne, Switzerland

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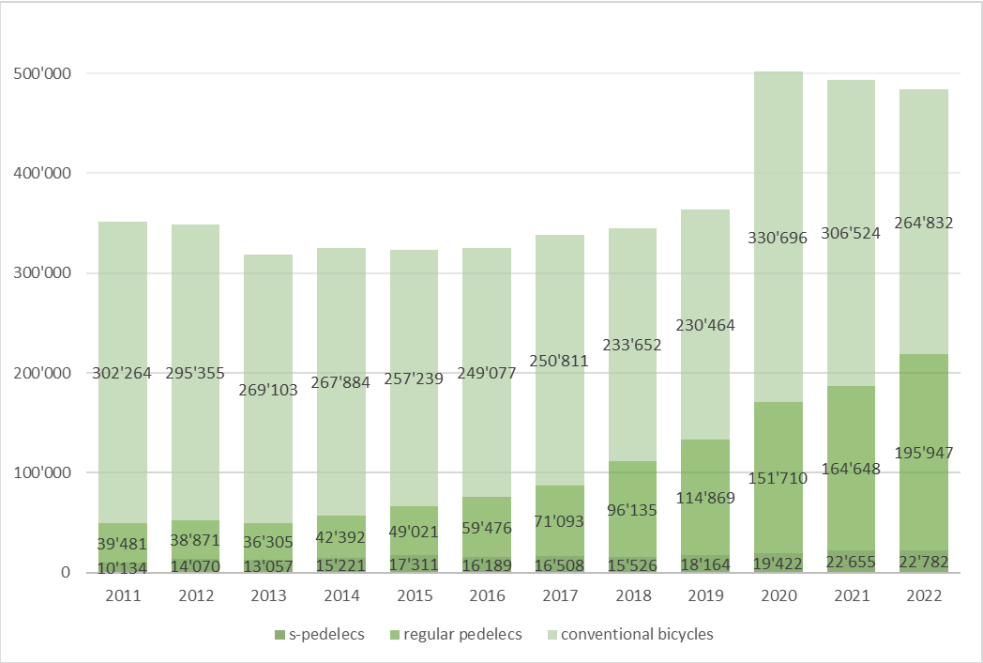
Introduction

S-pedelecs within the context of increased e-bike use

1 Although electric mobility is growing in the automotive domain, the greatest increase in Europe has been for electrically assisted bicycles, or e-bikes. They include both pedelecs[1] with a pedalling assistance up to 25 km/h, and s-pedelecs ('speed-pedelecs') with an assistance up to 45 km/h. Not considered in this paper are electric bicycles which can be ridden without the need to pedal.

2 In 2022, e-bike sales in Switzerland represented 45% of adult bicycle sales (Figure 1). E-bikes are increasingly driving the bicycle market, while the importance of traditional bikes is waning. From 2012 to 2015, one in four e-bikes sold was an s-pedelec and, although this has decreased to 10%, gross sales are increasing (almost 23,000 s-pedelecs were sold in 2021, compared to 10,000 in 2011). The share of s-pedelecs in e-bike sales in Switzerland (10%) and Belgium (4%[2]) are significantly higher than in other EU countries, such as the Netherlands (0.9%[3]) or Germany (0.5%[4]).

Figure 1. Bicycle, pedelec and s-pedelec sales in Switzerland from 2011 to 2022.



N.B. Velosuisse "represents the most important manufacturers, importers, wholesalers and agencies in the bicycle industry based in Switzerland"

Source: https://www.velosuisse.ch/en/portrait/

Previous research

3 Our literature review addresses the profile of s-pedelec users, their motivations and barriers, and their relationship with other transport modes. We have tried to distinguish s-pedelecs from pedelecs. However, research is much less developed for s-pedelecs and, although many studies include both types of e-bike, the proportion of s-pedelecs is often insufficient to warrant any substantial comparison.

User profiles

4 Firstly, the literature finds that s-pedelec users are more likely to be male (Schleinitz *et al.*, 2017). According to De Bruijne (2016) and Hendricks (2017), males outnumber females four to one. Banerjee *et al.* (2022) highlight that men are more likely to cycle long distances, which also explains why they resort more to s-pedelecs. There are, however, contradicting results when it comes to the user profiles for pedelecs depending on the context. While some studies tend to show a majority of female (Haustein & Moller, 2016), others find the opposite result (Wolf & Seebauer, 2014; Johnson & Rose, 2013).

5 In terms of age, Renard *et al.* (2017) estimate 65% of s-pedelec users to be aged over 45, while Hertag *et al.*, (2018) find 66% to be older than 50. Schleinitz *et al.* (2017) also find people over 45 to be overrepresented among s-pedelec users. An overrepresentation of mature users between 40 and 65 years is also found among pedelec users (Johnson & Rose, 2013; MacArthur *et al.,* 2014). S-pedelec users have high socioeconomic and educational status in comparison to the population as a whole (Hendricks, 2017). Here

again, a similar trend is found for pedelec owners, whose income and education levels are usually above average (Johnson & Rose, 2013; MacArthur *et al.*, 2014).

6 On a geographical level, pedelec ownership is higher in suburban and rural areas than in cities (Preißner *et al.,* 2013; Wolf & Seebauer, 2014), a similar pattern to conventional bicycle ownership. However, both pedelecs and s-pedelecs are used more frequently in urban than in rural areas (Ravalet *et al.*, 2019).

7 The variability of the results suggests that the profiles of pedelecs users are highly dependent on national and territorial contexts, as well as on the study period, as this practice has evolved very rapidly in recent years.

Motivations

8 The motivations for purchasing pedelecs are linked to exercise, health and a desire to reduce car use (Buffat *et al.*, 2014; Rérat 2021). Purchase motivations for s-pedelecs are similar and include environmental aspects, pleasure (6T, 2019), health, exercise (Van den Steen *et al.*, 2019), speed (Van der Salm *et al.*, 2022) and the possibility to travel longer distances (Plazier *et al.*, 2017). The main difference between both types of e-bikes may lie in which other modes of transport they are compared to. Buyers may compare the benefits offered by s-pedelecs not only with conventional bicycles, but also with motorised vehicles. Thus, buying an s-pedelec may be a way to cycle faster than with a conventional bicycle or pedelec, or as a cheaper or more sustainable compared to cars or motorized two-wheelers (6T, 2019).

9 The literature does not allow us to distinguish pedelecs from s-pedelecs regarding the motivations for replacing motorised modes. However, several studies find a link between buying a pedelec and a desire to replace car trips (Johnson & Rose, 2013; MacArthur *et al.*, 2014; Popovich *et al.*, 2014).

Relationship to other transport modes

10 In contrast to regular pedelecs, the effects of s-pedelecs on other modes are not currently well known. However, a study in Switzerland that included 39% of s-pedelec users indicates that e-bikes replace car trips (Buffat *et al.*, 2014). Some pedelec trials also showed some success in breaking motorists' habits (Fyhri & Fearnley, 2015; Fyhr *et al.,* 2017; Moser *et al.,* 2018).

11 Pedelecs and s-pedelecs have similarities with cycling and in the case of s-pedelecs, with motorised two-wheelers. In countries with a high rate of cycling, pedelecs may replace trips by conventional bicycle, as shown in the Netherlands by Lee *et al.* (2015), Kroesen (2017) and Sun *et al.* (2020), as well as in Austria (Wolf & Seebauer, 2014). In less cycle-friendly countries, pedelecs may be more likely to replace car trips (Bigazzi & Wong, 2020).

12 A similar positive relationship exists between household ownership of pedelecs and motorised two-wheelers. In Switzerland, 8.4% of owners of motorised two-wheelers also own a pedelec, compared to 5.5% of non-owners (Ravalet *et al.*, 2019). In the Netherlands, Kroesen (2017) shows that pedelec ownership replaces bicycle ownership but has little effect on car ownership.

13 Few studies have considered s-pedelecs within broader travel patterns. Renard *et al.* (2017) estimated the average yearly distance achieved with an s-pedelec to be 3,502 km,

which is 75% greater than that achieved with a pedelec (1,969 km). Of these 3,502 km, 54% were previously performed via a motorised mode (car, motorized two-wheelers), higher than for regular pedelecs (46%) (Renard *et al.*, 2017). Meanwhile, 6T (2019), Hendricks (2017) and Hendricks & Sharmeen (2020) find s-pedelecs to have low intermodality[5], meaning that they are rarely used in conjunction with other travel modes (e.g. train). This could be due not only to their greater range, but also to a lack of secure bicycle parking around train stations.

Aims of the paper

14 Our research question then is: Which place do S-pedelecs occupy, compared to pedelecs, among transport modes and to what extent can their greater speed help them compete with cars more efficiently than pedelecs? We address the profile of s-pedelec users, their reasons for choosing this transport mode, which trips s-pedelecs are used for, and how they impact other transport modes.

15 Since s-pedelecs assist cyclists up to a higher speed, they are better suited to travelling long distances and differ in the role they play within competing travel options. Following Kroesen (2017), we study the impact of s-pedelecs on both modal shift (reducing trips made by other modes), and ownership (replacing car ownership, actual and/or planned), by investigating their contribution to a partial or total demotorisation of households.

16 We use data from a survey of e-bike owners (both pedelecs and s-pedelecs) in Lausanne, a city of 149,000 inhabitants in Switzerland, the country with the highest penetration rate of s-pedelecs. We compare both pedelecs and s-pedelecs in terms of profiles, motivations for purchase, travel patterns and modal shift effects. This comparison enables to gauge the potential for s-pedelecs to develop within a sustainable transport system. We also fill a gap in the s-pedelec literature for which data is still scarce and often relies on very small sample sizes.

Context and methods

17 The Swiss context is particularly interesting because of both a rapid rise in e-bike ownership, and a high share of s-pedelecs in international comparison. According to the Swiss micro-census on mobility and transport (MCMT, 2015)[6], in 2015 6.1% of Swiss households owned at least one pedelec and 2% owned at least one s-pedelec. In 2021, these rates reached 17.9% and 2.8% respectively[7].

18 Lausanne is the 4th Swiss city in population size (149,000 inhabitants). It has a low modal share of cycling (1.6% of all trips; 7% nationally) (OFS & ARE, 2017), mainly explained by the hilly topography (370m by the lake and about 650m to the highest neighbourhoods) and traffic conditions. Lausanne also has a low share of e-bike owning households as 3.3% owned at least one pedelec and 1% at least one s-pedelec. E-bikes could, however, represent a way to cope with topography and increase cycling, which is an explicit goal of the municipality.

19 The City of Lausanne has subsidized the purchase of e-bikes since 2000. At the time of the survey this subsidy accounted for 15% of the price (up to 500 Swiss francs) and was available to any inhabitant. The subsidy is very well known, and shops inform their

customers about it. The database we use in this article includes most e-bikers (except when they bought their e-bike outside the region or before moving to Lausanne). In summer 2018, we sent the questionnaire (via post or e-mail) to 3400 beneficiaries, from which 1466 usable responses were obtained (45.5%).

20 This paper is based on questions about personal characteristics, motivations, use (frequency and reasons for travel) and modal shift (previous modes for journeys made by e-bike, changes in the use of other modes and renunciation of vehicles/public transport passes). Of the participants in our sample (Table 1), 84.9% (n=1205) currently own a pedelec and 15.1% (n=215) own an s-pedelec. No participant mentioned owning both a pedelec and an s-pedelec.

Table 1. E-bike ownership.

	Number	Percentage
Pedelec (25 km/h)	1205	84.9%
S-pedelec (45 km/h)	215	15.1%
TOTAL	1420	100%

21 The paper compares pedelec users with s-pedelec users to understand the specificities of the latter and to assess the extent to which s-pedelecs may lead to reduced use of other modes of transport. We first analyse user profiles, the motivations for purchasing (to better understand the qualities sought and whether reducing car use is an explicit goal) and uses in order to report on how s-pedelecs might become a relevant modal alternative. We finally address modal shifts and changes in vehicle ownership.

22 To compare the differences between pedelec and s-pedelec users, we present cross tabulations between both groups. The results of the chi-squared tests are not presented, because the pedelec and s-pedelec owner samples are different in size and structure. Thereafter, to assess whether differences between both groups are statistically significant, we use logistic regression models. Binary models compared s-pedelec and pedelec users. They include a wide range of variables (household type, age, gender, employment, education and income) and measure the effect of owning an s-pedelec, all other things being equal. This effect is expressed in odds ratio: the further the result is from 1, the greater the impact of the variable.

Results

S-pedelecs user characteristics

23 This S-pedelec users are over-represented among the 40–59 age group, as are men, people with a high level of education and high earners (Table 2). The most important difference concerns gender, with 73.2% of s-pedelec users being men, while a majority of regular pedelec users are women (57.9%).

Table 2. Profile of pedelec and s-pedelec users.

		Pedelec	S-pedelec	Mean
Household type	Single person	18.7%	12.6%	17.8%
	Couple without a child	29.5%	24.8%	28.8%
	Couple with at least one child	40.4%	55.6%	42.7%
	Others	11.4%	7.0%	10.8%
Age	Less than 40	37.0%	29.9%	35.9%
	40 to 59	43.0%	57.5%	45.2%
	60 and over	20.0%	12.6%	18.9%
Gender	Female	57.9%	29.8%	53.0%
	Male	42.1%	73.2%	47.0%
Professional situation	In full-time work	31.4%	22.6%	30.0%
	In part-time work	49.2%	66.8%	52.0%
	Retired	11.9%	6.3%	11.0%
	Others	7.5%	4.3%	7.0%
Educational level	Without tertiary education	36.1%	30.9%	35.3%
	With tertiary education	63.9%	69.1%	64.7%
Income	Less than CHF 6,000 per month	52.7%	33.8%	49.6%
	Between CHF 6,000 and CHF 9,000 per month	29.9%	34.3%	30.7%
	More than CHF 9,000 per month	17.4%	31.9%	19.7%

24 A logistic regression model comparing pedelec and s-pedelec users (Table 3) confirms that men are significantly more likely than women to own an s-pedelec, as are people between 40 and 59 rather than those younger than 40. People living in families with children and with high income (more than CHF 9,000 per month) are also more likely to own an s-pedelec. However, neither employment status nor level of education has a significant effect.

Table 3. Logistic regression on the likelihood of owning an s-pedelec compared to a pedelec.

dependent variable : owning a S-pedelec (rather than a 25 km/h pedelec)			
		B	Exp(B)
Household type	Single person (ref.)		
	Couple without a child	0,242	1,273
	Couple with at least one child	0,460	1.584*
	Others	0,024	1,025
Age	Less than 40 y.o. (ref.)		
	From 40 to 59 y.o.	0,387	1.473**
	60 y.o. and more	-0,544	0,580
Gender	Woman (ref.)		
	Man	1,175	3.240***
professional situation	Full-time worker (ref.)		
	Part-time worker	0,123	1,131
	Retired	0,082	1,086
	Others	-0,476	0,621
educational level	Without tertiary education (ref.)		
	With tertiary education	0,119	1,127
Incomes	Less than CHF 6000 per month (ref.)		
	Between CHF 6'000 and CHF 9'000 per month	0,151	1,163
	More than CHF 9'000	0,405	1.499*
Constant		-3,036	0.048***

* p<0.1; ** p<0.05; ***; p<0.01
Model characteristics: Likelihood log. 997.440; Cox R^2 0.077; Nagelkerke R^2 0.132; p<0.001

Motivation for purchasing and uses

25 Participants had to indicate their level of agreement to a list of reasons for buying an e-bike on a four-point Likert scale from strongly disagree to strongly agree.

26 The most important motivations (Table 4) are being able to ride uphill and having an alternative to the car or public transport (94% of respondents agree with both). More than 80% are motivated by the ability to exercise while travelling, by the speed and/or distance enabled by an s-pedelec and by its innovative nature.

Table 4. Percentage of positive answers (agree or strongly agree) for motivations to purchase a pedelec or s-pedelec.

	Pedelec	S-pedelec	Differences in percentage points
Having an alternative to the car or public transport	88 %	94 %	+6
Being able to cycle in hilly areas	96 %	94 %	-2
Doing exercise while travelling	87 %	86 %	-1
Being able to go faster or further than by conventional bicycle	71 %	83 %	+12
Adopting an innovative form of mobility	78 %	82 %	+4
Cycling more or continuing to cycle	86 %	77 %	-9
Enjoying the pleasure of riding an e-bike	81 %	71 %	-10
Carrying goods / children	37 %	33 %	-4

27 Table 5 tests the effect of the motivations for purchasing an e-bike on the likelihood of s-pedelec ownership (compared to pedelec). The regression analysis indicates that four motivations play a role in the decision to buy an s-pedelec: being able to go faster or further than with a conventional bicycle; enjoying the pleasure of riding an e-bike; cycling more or continuing to cycle; and having an alternative to the car or public transport[8].

Table 5. Logistic regression on s-pedelec ownership, including motivations.

dependent variable : owning a S-pedelec (reference : owning a pedelec)			
		B	Exp(B)
Household type	Single person (ref.)		
	Couple without a child	0.215	1.239
	Couple with at least one child	0.590	1.803***
	Others	0.064	1.088
Age	Less than 40 y.o. (ref.)		
	From 40 to 59 y.o.	0.462	1.587***
	60 y.o. and more	-0.516	0.597
Gender	Woman (ref.)		
	Man	1.144	3.140***
professional situation	Full-time worker (ref.)		
	Part-time worker	0.046	1.047
	Retired	0.249	1.283
	Others	-0.596	0.551
educational level	Without tertiary education (ref.)		
	With tertiary education	0.033	1.033
Incomes	Less than CHF 6000 per month (ref.)		
	Between CHF 6'000 and CHF 9'000 per month	0.180	1.197
	More than CHF 9'000	0.431	1.539
Motivation : Cycling more or continuing to cycle	rather or completely agree	-0.541	0.582
	rather or completely disagree		
Motivation : Going faster or further than with a conventional bicycle	rather or completely agree	0.860	2.362***
	rather or completely disagree		
motivation : Cycling despite the gradient	rather or completely agree	-0.571	0.565
	rather or completely disagree		
Motivation : Having an alternative to the car or public transport	rather or completely agree	0.747	2.111***
	rather or completely disagree		
Motivation : Carrying goods / children	rather or completely agree	-0.200	0.818
	rather or completely disagree		
Motivation : Enjoying the pleasure of riding a e-bike	rather or completely agree	-0.572	0.565***
	rather or completely disagree		
Motivation : adopting an innovative form of mobility	rather or completely agree	0.355	1.426
	rather or completely disagree		
Motivation : Doing exercice while traveling	Pedelec (25 km/h)	0.236	1.266
	S-pedelec (45 km/h)		
Constant		0.734	2.084

* p<0.1; ** p<0.05; ***; p<0.01
Model characteristics: Likelihood log. 891.597; Cox R^2 0.107; Nagelkerke R^2 0.187; p<0.001

28 In comparison to a pedelec, buying an s-pedelec is more related to motivations of time/speed and space/distance, qualities which make s-pedelecs a real alternative to public transport or car use. On the other hand, pedelec buyers more often justify their purchase by the ability to continue or increase cycling, or the pleasure of cycling. While not as important, these two motivations remain strong for s-pedelecs as well (77% and 71% agree respectively).

29 E-bikes make it possible to cover longer distances than conventional bicycles. When asked the maximum distance they were willing to travel by e-bike, 57% chose 15 km or more. S-pedelecs enable even greater distances: 74% of them consider that they can travel 15 km or more, compared to 54% of pedelec owners.

Table 6. Types of e-bike use by e-bike category.

	E-bike used…			
	…to travel to work	… to go shopping	…to travel to leisure activities	…for recreational trips
Pedelec	70.1 %	57.9 %	62.0 %	67.5 %
S-pedelec	81.2 %	59.1 %	55.7 %	48.8 %
Mean	71.8 %	58.2 %	61.0 %	64.6 %

30 Table 6 indicates that s-pedelecs are more often used to travel to work than pedelecs, while the opposite is true for leisure activities and recreational trips. This result fits within aforementioned purchase motivations. S-pedelecs are seen as more suited for long-distance, commuting trips, and less so for recreational trips, compared to regular pedelecs. A further explanation is gender differences, with s-pedelecs being primarily

owned by men, who due to traditional household roles tend to cycle more for commuting purposes. Lastly, differences in age play a role, as retired users, who engage more in recreational trips, are less present among s-pedelec users.

31 To confirm these differences, we used a logistic regression model which controls for sociodemographic and social characteristics (Table 7). This model reveals that differences between both categories are significant for maximal distances and for trip purposes, with s-pedelec owners more likely to commute to work, and less likely to cycle for leisure or recreation[9].

Table 7. Logistic regression on s-pedelec ownership including maximal distances and types of use.

dependent variable : owning a S-pedelec (reference : owning a pedelec)			
		B	Exp(B)
Household type	Single person (ref.)		
	Couple without a child	0.215	1.239
	Couple with at least one child	0.377	1.458
	Others	0.020	1.021
Age	Less than 40 y.o. (ref.)		
	From 40 to 59 y.o.	0.412	1.510**
	60 y.o. and more	-0.374	0.688
Gender	Woman (ref.)		
	Man	1.090	2.974***
professional situation	Full-time worker (ref.)		
	Part-time worker	0.055	1.056
	Retired	0.034	1.035
	Others	-0.555	0.574
educational level	Without tertiary education (ref.)		
	With tertiary education	0.176	1.193
Incomes	Less than CHF 6000 per month (ref.)		
	Between CHF 6'000 and CHF 9'000 per month	0.134	1.144
	More than CHF 9'000	0.460	1.584*
How far are you willing to travel by e-bike?	5km (ref.)		
	10km	-0.125	0.882
	15km	0.860	2.362***
	20km	1.204	3.333***
	Beyond 20km	1.176	3.243***
Do you use e-bike to travel to work?	No (ref.)		
	Yes	0.456	1.578**
Do you use e-bike to go shopping?	No (ref.)		
	Yes	0.104	1.110
Do you use e-bike to travel to leisure activities?	No (ref.)		
	Yes	-0.360	0.698*
Do you use e-bike for recreational trips?	No (ref.)		
	Yes	-0.698	0.498***
Constant		-3.346	0.035***

* p<0.1; ** p<0.05; ***; p<0.01
Model characteristics: Likelihood log. 898.680; Cox R^2 0.126; Nagelkerke R^2 0.213; p<0.001

Modal shift effects of s-pedelecs

32 We address modal shift firstly through the following question: “Since you bought an e-bike, do you use the other modes of transport more, less, or the same as before?”.

33 In terms of their overall effect on transport habits, s-pedelec owners have reduced their use of individual motorised transport more than pedelec owners (Table 8). This is the case for the car (59.1% vs 50%) and motorised two-wheelers (30.9% vs 22.1%). Conversely, the decrease in use of public transport is stronger for pedelec users (62.3% vs 54.8%). 8.6% of S-pedelec users (vs 0% for pedelec users) also increased their use of conventional bicycle.

Table 8. Effects of the e-bike on the other modes.

Evolution in the use of walking			Evolution in the use of conventional bicycle		
	Pedelec	S-pedelec		Pedelec	S-pedelec
Increase	5,9 %	5,3 %	Increase	0,0 %	8,6 %
Decrease	37,7 %	35,6 %	Decrease	46,6 %	43,3 %
No change/Not concerned	56,4 %	59,1 %	No change/Not concerned	45,4 %	48,1 %
Total	100,0 %	100,0 %	Total	100,0 %	100,0 %

Evolution in the use of motorized two-wheelers			Evolution in the use of public transport		
	Pedelec	S-pedelec		Pedelec	S-pedelec
Increase	4,0 %	5,3 %	Increase	4,2 %	5,2 %
Decrease	22,1 %	30,9 %	Decrease	62,3 %	54,8 %
No change/Not concerned	73,9 %	63,8 %	No change/Not concerned	33,6 %	40,0 %
Total	100,0 %	100,0 %	Total	100,0 %	100,0 %

Evolution in the use of the car		
	Pedelec	S-pedelec
Increase	2,3 %	2,4 %
Decrease	50,0 %	59,1 %
No change/Not concerned	47,7 %	38,5 %
Total	100,0 %	100,0 %

34 A logistic regression model (Table 9) confirms that the most important difference between both vehicles is the lower effect of s-pedelecs on reducing public transport use compared to regular pedelecs.

Table 9. Logistic regression on s-pedelec ownership, including changes to the use of other transport modes.

dependent variable : owning a S-pedelec (reference : owning a pedelec)			
		B	Exp(B)
Household type	Single person (ref.)		
	Couple without a child	0.272	1.313
	Couple with at least one child	0.479	1.615*
	Others	0.025	1.025
Age	Less than 40 y.o. (ref.)		
	From 40 to 59 y.o.	0.328	1.388*
	60 y.o. and more	-0.644	0.525*
Gender	Woman (ref.)		
	Man	1.157	3.182***
professional situation	Full-time worker (ref.)		
	Part-time worker	0.082	1.086
	Retired	0.091	1.095
	Others	-0.455	0.634
educational level	Without tertiary education (ref.)		
	With tertiary education	0.158	1.172
Incomes	Less than CHF 6000 per month (ref.)		
	Between CHF 6'000 and CHF 9'000 per month	0.174	1.190
	More than CHF 9'000	0.372	1.450
Reduced use of walking	No (ref.)		
	Yes	0.139	1.149
Reduced use of conventional bicycles	No (ref.)		
	Yes	0.143	1.154
Reduced use of motorised two-wheeler	No (ref.)		
	Yes	0.277	1.320*
Reduced use of the car	No (ref.)		
	Yes	-0.159	0.853
Reduced use of public transport	No (ref.)		
	Yes	-0.388	0.682**
Constant		-2.941	0.053***

* p<0.1; ** p<0.05; ***; p<0.01
Model characteristics: Likelihood log. 988.789; Cox R^2 0.083; Nagelkerke R^2 0.142; p<0.001

35 In addition to the replacement of trips, we have considered whether e-bike adoption leads to giving up the ownership, or planned purchase, of a vehicle or a public transport pass (Table 10). The question formulated was: “Did using an e-bike lead you

to give up ownership of the following modes?". Giving up ownership of a vehicle does not necessarily mean that the respondent sold it after buying an e-bike. They may also have decided against buying a vehicle (or renewing their public transport pass).

Table 10. Giving up ownership of individual modes and public transport passes according to e-bike category.

	Giving up ownership, or planned purchase, of…			
	…conventional bicycle	…motorised two-wheeler	…the car	…public transport
Pedelec	35.5 %	41.5 %	18.0 %	34.9 %
S-pedelec	22.8 %	51.2 %	22.0 %	31.9 %
Mean	32.9 %	43.7 %	18.6 %	34.5 %

36 S-pedelecs are significantly more likely than pedelecs to make owners to renounce or decide against ownership of a motorised two-wheeler (51.2% *vs* 41.5% respectively). Meanwhile, pedelec users more often give up conventional bicycle ownership (35.5% *vs* 22.8%). These results are confirmed by the logistic regression model (Table 11) and suggest that s-pedelecs represent an alternative to motorised two-wheelers (due to their similar speed and range), while pedelecs are positioned as an alternative to conventional bicycles. One third of e-bikers have given up a public transport pass (no significant difference between s-pedelecs and pedelecs). Lastly, e-bike adoption leads 20% of participants (also no difference) to give up ownership of a car, which constitutes a high percentage given the long-term nature of car ownership and the short time for which most respondents have owned an e-bike.

Table 11. Logistic regression on s-pedelec ownership, including changes in ownership of other transport modes.

dependent variable : owning a S-pedelec (reference : owning a pedelec)			
		B	Exp(B)
Household type	Single person (ref.)		
	Couple without a child	0.196	1.216
	Couple with at least one child	0.518	1.679
	Others	0.114	1.120
Age	Less than 40 y.o. (ref.)		
	From 40 to 59 y.o.	0.480	1.616**
	60 y.o. and more	-0.791	0.453*
Gender	Woman (ref.)		
	Man	1.198	3.314***
professional situation	Full-time worker (ref.)		
	Part-time worker	0.124	1.132
	Retired	0.066	1.069
	Others	-0.510	0.601
educational level	Without tertiary education (ref.)		
	With tertiary education	0.061	1.062
Incomes	Less than CHF 6000 per month (ref.)		
	Between CHF 6'000 and CHF 9'000 per month	0.162	1.176
	More than CHF 9'000	0.292	1.339
Giving up ownership of conventional bicycle	No (ref.)		
	Yes	-0.658	0.518***
Giving up ownership of motorised two-wheeler	No (ref.)		
	Yes	0.516	1.-676***
Giving up ownership of the car	No (ref.)		
	Yes	0.311	1.365
Giving up ownership of public trnaposrt pass	No (ref.)		
	Yes	-0.165	0.848
Constant		-3.140	0.043***

* p<0.1; ** p<0.05; ***; p<0.01
Model characteristics: Likelihood log. 887.682; Cox R^2 0.101; Nagelkerke R^2 0.173; p<0.001

37 Overall, the effect of s-pedelecs on other modes gives an indication of the past transport habits of e-bike users. Since adopting an e-bike, s-pedelec users have reduced their reliance on motorised two-wheelers, whereas for pedelec users, public transport use has declined most.

Discussion

Limitations and future research

38 Before discussing our results, it is important to acknowledge some potential limitations of this exploratory study.

39 As with any stated preference survey, our results may include some self-reporting bias. For instance, answering retrospective questions may be difficult for people whose purchase is several years old. It should be noted, however, that two-thirds of respondents received a subsidy in the two years before the survey.

40 Another potential limitation might concern a social desirability bias. To limit this, we paid special attention in designing the survey to use neutral questions. The social desirability bias is certainly the same between pedelec and s-pedelec users. The differences observed are therefore not due to this bias.

41 Methodologically, further data could be collected through objective measuring methods (e.g. GPS tracking and odometers) to better quantify the use of s-pedelecs.

Rather than a cross-sectional study, it would also be useful to take a longitudinal approach to better understand how s-pedelecs fit within individual cycling trajectories over the life course (Marincek & Rérat, 2021).

42 Beyond these factors, it is important to point out that this study is exploratory as the number of S-pedelecs users is still low, although the strong momentum of conventional cycling and pedelecs should bring about rapid changes in mobility practices in the years to come.

Main findings: impacts of s-pedelecs on modal shift

43 While pedelecs expand cycling practice in terms of population groups (more women, people over 40s and parents) (e.g. Rérat, 2021a), s-pedelecs are most popular with men (confirming the findings of other studies, such as Schleinitz *et al.* (2017)), those aged 40–59 and employed people. Regarding age, the youngest and oldest groups are underrepresented among s-pedelec users.

44 The gender imbalance may be explained by the early stage of diffusion of s-pedelecs, with its early adopters being more likely to be male, of average age and with a high level of education. Another hypothesis is that the higher speed of s-pedelecs might lead to a lower perceived safety, putting off women, who tend to be more safety-conscious (Graystone *et al.*, 2022). Lastly, s-pedelecs' similarity to motorised two-wheelers may attract more men, who have greater experience of motorised two-wheelers as a result of gendered travel socialisation. S-pedelec users make use of electric assistance to facilitate cycling in hilly conditions, as is the case with pedelecs, but also to cycle faster and further. S-pedelecs provide a form of cycling (as shown by their users' motivations) but extend this practice in terms of space/distance and time/duration. The use of s-pedelecs gravitates towards commuting trips, with longer distances than for pedelecs. With an assistance of up to 45 km/h, the s-pedelec offers a clear speed advantage on longer flat sections compared to pedelecs.

45 Given these attributes, s-pedelecs compete more directly than pedelecs with cars and motorised two-wheelers, offering a viable alternative to individual motorised vehicles on the urban or metropolitan scale. This effect of s-pedelecs was measured in terms of modal shift, and in terms of vehicle ownership.

46 In terms of modal shift, 59.1% of s-pedelec owners reduced their car use (*vs* 50% for pedelecs) and 30.9% their motorised two-wheeler use (*vs* 22%). At the same time, s-pedelec users reduced fewer trips by public transport (55%) than regular pedelec users (62%). This last result is the significant one in a model analysis.

47 We then consider the way vehicle ownership has evolved since the e-bike was bought. 51.2% of s-pedelec users have given up or decided not to own a motorised two-wheeler (*vs* 40% of pedelec users). In addition, up to 20% of s-pedelec users stated that they had given up either ownership of a car or plans to buy one, which is especially impressive since most people surveyed had owned an e-bike for less than 2 years. In contrast, more pedelec users gave up ownership of a conventional bicycle (35.5% *vs* 25%). These results confirm that s-pedelecs represent an alternative to motorised modes of transport, rather than to conventional cycling. Thus, the modal shift potential of s-pedelecs is especially high for motorised modes such as the car or motorised two-wheelers.

Conclusion and policy recommendations

48 E-bikes have several advantages. Like bicycles, they have a low weight and small space requirements. They are an active form of mobility that requires their users to exert muscular energy, bringing health benefits (e.g. Castro *et al.,* 2019). They also have sustainability benefits, as their ecological footprint is much smaller than that of cars or motorised two-wheelers, whatever the type of propulsion (International Transport Forum, 2020). While there is a growing body of literature on pedelecs (with an assistance up to 25 km/h), the specific effects of s-pedelec (with an assistance up to 45 km/h) have remained less known. We contribute to filling this gap through a survey in Lausanne, Switzerland, the country with the highest penetration rate (more than 10% of all new e-bikes).

49 To conclude, our results suggest that, given their modal shift potential, it is important to promote the development of s-pedelecs in place of motorised individual vehicles. At the same time, one should avoid decreasing interest in slower pedelecs[10], which arguably fit better the needs of a wide variety of people, and offer better integration into low-speed urban centres, being more similar to regular bicycles.

50 We cannot prove with our data that higher prices of S-pedelecs hinder their sales. Nonetheless, their purchase could be supported through a subsidy to allow the diffusion of such vehicle beyond higher socioeconomic categories.

51 Yet from a political perspective, the development of s-pedelecs remains hampered by a lack of clear vision of the role and place of these vehicles on the road. Increasing numbers of s-pedelecs are a further argument for developing the provision of high-capacity cycling infrastructure to ensure proper cohabitation with conventional cyclists, which are also growing in number (Hendriks & Sharmeen, 2020). However, cohabitation between conventional bicycles, pedelecs and s-pedelecs may be tricky due to speed differentials (although the average speed of s-pedelecs is actually lower than 45 km/h). The Swiss case shows that a legal framework which views s-pedelecs as a type of (e-)bike allows for their development, but also creates cohabitation issues.

52 Instead of general principles, a more nuanced and contextualised appraisal of the place of s-pedelecs depending on the volume of traffic, the type and width of cycling routes, and the presence of less experienced users (e.g. children near a school) may be relevant in order to fully take advantage of the potential of s-pedelecs, while considering their differences with other (e-)bikes.

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NOTES

1. Pedal electric bicycle.
2. https://leva-eu.com/
3. https://www.bovag.nl/BovagWebsite/media/BovagMediaFiles/Cijfers/Mobiliteit%20in%20cijfers/Mobiliteit-in-Cijfers-Tweewielers-2019.pdf?ext=.pdf
4. https://www.ziv-zweirad.de/marktdaten/
5. Intermodality refers to the use of several modes during the same trip.
6. MCMT is a nationwide travel survey conducted every five years by the Swiss Federal Office for Spatial Development and the Swiss Federal Statistical Office.
7. https://www.bfs.admin.ch/bfs/fr/home/statistiques/mobilite-transports/transport-personnes/comportements-transports.assetdetail.24165262.html
8. In both tables 4 and 5 the motivation "having an alternative to the car or public transport" is presented as it was in the survey. This formulation does not allow us to distinguish car and public transport although it would have been relevant to do so.
9. S-pedelecs enable their users to cover greater distances and are more likely to be used to commute. Home-work distance is presumably a determinant factor in the purchasing choice of a S-pedelec rather than a pedelec. Unfortunately, as this variable was not present in our survey, this hypothesis cannot be tested.
10. https://ecf.com/files/speed%20ped%20policy%20document_final_0.pdf

ABSTRACTS

Sales of electrically assisted bicycles (e-bikes) have risen significantly in Europe. Almost all e-bikes provide assistance up to 25 km/h (“pedelecs”), but in Switzerland, more than 10% are speed pedelecs (s-pedelecs) offering assistance up to 45 km/h. Due to their increased speed, s-pedelecs hold great potential for long-range trips outside urban areas. Yet, to date, they have received very little academic attention. This exploratory paper fills this gap by questioning the place S-pedelecs have, compared to pedelecs, among transport modes and to what extent their greater speed can help them compete with cars more efficiently than pedelecs? We address in this paper, for both pedelecs and S-pedelecs users, the demographic characteristics, motivations for purchasing, travel patterns, as well as the modal shift effects. It draws on a survey conducted in Lausanne, Switzerland, among users of n=215 s-pedelecs and n=1205 pedelecs.
Compared to regular e-bikers, s-pedelec users are more likely to be male, but otherwise share similar motivations to riding their e-bike. S-pedelecs are often used for long-distance commuting and compete more with cars and motorised two-wheelers. As a result, 60% of s-pedelec owners use a car less, and 20% decided to give up car ownership. Regression models confirms these results. Given the potential of s-pedelecs to replace motorised modes, we recommend devoting more attention to the development of infrastructure, such as interurban cycle highways, to accommodate them on a metropolitan scale.

Les ventes de vélos à assistance électrique (e-bikes) ont considérablement augmenté en Europe. Presque tous les vélos électriques offrent une assistance jusqu’à 25 km/h (« pedelecs »), mais en Suisse, plus de 10% sont des speed pedelecs (s-pedelecs) offrant une assistance jusqu’à 45 km/h. En raison de leur vitesse accrue, les s-pedelecs présentent un grand potentiel pour les trajets de longue distance en dehors des zones urbaines. Pourtant, à ce jour, ils n’ont reçu que très peu d’attention de la part des universitaires. Cet article exploratoire comble cette lacune en s’interrogeant sur la place qu’occupent les S-pedelecs, par rapport aux pedelecs parmi les modes de transport et sur la mesure dans laquelle leur plus grande vitesse peut les aider à concurrencer les voitures plus efficacement que les pedelecs. Dans cet article, nous abordons, pour les utilisateurs de pedelecs et de S-pedelecs, les caractéristiques démographiques, les motivations d’achat, les modes de déplacement, ainsi que les effets du transfert modal. Il s’appuie sur une enquête menée à Lausanne, en Suisse, auprès d’utilisateurs de 215 s-pedelecs et de 1205 pedelecs.
Par rapport aux cyclistes électriques réguliers, les utilisateurs de s-pedelecs sont plus souvent des hommes, mais ils partagent par ailleurs des motivations similaires à celles des cyclistes électriques. Les s-pedelecs sont souvent utilisés pour les trajets domicile-travail sur de longues distances et concurrencent davantage les voitures et les deux-roues motorisés. En conséquence, 60% des propriétaires de s-pedelecs utilisent moins la voiture, et 20% ont décidé de renoncer à la posséder. Les modèles de régression confirment ces résultats. Étant donné le potentiel des s-pédélecs à remplacer les modes motorisés, nous recommandons d’accorder plus d’attention au développement d’infrastructures, telles que les autoroutes cyclables interurbaines, afin d’améliorer la qualité de vie des habitants de la ville.

INDEX

Keywords: pedelecs, speed-pedelecs, cycling, e-bike, modal shift, Switzerland
Mots-clés: vélos électriques, vélos électriques rapides, cyclisme, e-bike, part modale, Suisse

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