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A push to cycling—exploring the e-bike's role in overcoming barriers to bicycle use with a survey and an intervention study

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ABSTRACT

In Norway, as in many countries, there is a political goal to increase bicycle use. The electric bicycle (e-bike) is a promising tool for achieving this goal, given the hilliness of the country. However, little is yet known about the deterrents of cycling in Norway in general, and in particular how the purchase of an e-bike could be stimulated.

In the current study, 5500 respondents from a convenience sample among car owners were asked about their perceptions of bicycling in general, and of e-bikes in particular as well as their willingness to pay (WTP) for an e-bike. Randomly selected participants ($N = 66$) were given access to an e-bike for a limited time (2 or 4 weeks). A second questionnaire captured the same perceptions and WTP post-intervention. The results were compared with a control group ($N = 214$).

The results showed that those who cycle the least were most interested in buying an e-bike and that prior knowledge of the e-bike corresponded with a higher desire to buy one. Pro-environmental values did not predict interest in e-bikes, neither did norms and attitudes toward cycling. The WTP for an e-bike increased after having experienced the benefits for those who used an e-bike compared to those who did not. Price reduction of the e-bike (e.g. VAT exemption), spread of knowledge among the wider population, and actions to offer an e-bike experience may therefore be effective strategies for further expansion of the e-bike in the transport system and thereby to increase bicycle use in Norway.

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Introduction

The ownership of electric bicycles (hereafter called e-bike) is increasing in the world. Asia, and especially China, has already witnessed a large growth in e-bike sales (Ji et al. 2012). In Europe, e-bike sales have been growing (COLIBI, 2013), while the USA is still far behind and e-bikes are still quite an uncommon sight (Popovich et al. 2014). The e-bike may be seen as an important "tool" for modal transitions in countries with low bicycle mode shares as the e-bike could reduce some barrier effects on cycling (i.e. hills and long distances). Still, international comparisons, with only few exceptions including Switzerland and Austria, indicate that the e-bikes have a larger market share in countries with existing *high* bicycling shares (Tronstad et al. 2013).

The rise of the e-bike is not uncontroversial. On the one hand, the e-bike has the potential to shift people from motorized to non-motorized travel and therefore positively contributing to society (Cherry et al. 2016). E-bikes may contribute to congestion reduction (Shao et al. 2012); they may have positive effect on public health by increased physical activity as a result of additional time spent cycling (Gojanovic et al. 2011) and may have positive implications for the environment as a result of a modal shift (Fyhri & Sundfør, 2014). For example, Fyhri and Fearnley (2015) found that participants who used an e-bike for two or four weeks had a substantial increase in their total bicycle use, both in absolute numbers and in mode share (i.e. a reduction in motorized travel). In another study (Sundfør, 2015), of actual e-bike *purchasers*' mode change, effects (i.e. reduction in motorized travel) were also large. On the other hand, potential downsides of e-bikes include potential lower levels of physical activity than riding regular bicycles over the same distance, that users and pedestrians may be exposed to higher levels of risk (Hu et al. 2014) and that production and disposal (especially of the battery) may be less environmentally friendly than regular bicycles (Li & Qian, 2014). Also, a study from China indicated that e-bike owners were *more* likely to consider purchasing a car in the near future (Ling et al. 2015).

General bicycle use and bike sharing, including their key barriers and facilitators have received extensive scientific attention in the past years (for overviews see Dill, 2009; Fishman, Washington, & Haworth, 2013; Heinen, van Wee, & Maat, 2010). Several sociodemographic, attitudinal, and transport characteristics have been associated with cycling. In general, cycling is found to be more common for men than women, and decreases when people get older (Heinen et al. 2010). Trip distance has also in most studies been reported as a main determinant of cycling (Wuerzer & Mason, 2015), but on short

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distances, an increase in trip distance increases the likelihood of cycling (Wang, Akar, & Guldmann, 2015).

The theory of planned behavior (TPB) states that a behavioral intention is the key determinant of actual behavior (Ajzen, 1991). Behavioral intentions are formed by a rational assessment regarding *attitudes* toward a specific behavior (behavioral beliefs and outcome evaluations), *subjective norms* (beliefs about approval or disapproval from important others regarding the behavior), and *perceived behavioral control* (beliefs about factors that may facilitate or impede the behavior) (Ajzen, 1991). Many studies have found that sociopsychological variables derived from the TPB such as attitudes, social norms, and perceived behavioral control predict the likelihood to cycle (Dill, Mohr, & Ma, 2014; Fernandez-Heredia, Monzon, & Jara-Diaz, 2014; Heinen & Handy, 2012; Lois, Moriano, & Rondinella, 2015; Piatkowski et al. 2015). In a review of psychological determinants of active travel, it was concluded that the TPB variables could predict active transport (Panter & Jones, 2010), but that there seemed to be a strong interaction with habit strength (Aarts, Verplanken, & vanKnippenberg, 1997), i.e. the degree to which bicycle use is automatized. Another theory that is often used to predict pro-environmental behavior is the Norm Activation Theory (Schwartz, 1992) where personal moral norms are hypothesized as predictors of behavior. The norms are activated when there exists an awareness of the need to solve an environmental problem, an understanding of the relationship between own actions and existence of the problem, an ascription of responsibility for solving the problem, and social support for performing the action alongside with personal capabilities. A number of studies have found relationships between the norm activation theory and pro-environmental behavior at the strategic level, such as decisions about car type (Flamm, 2009; Nayum & Klockner, 2014; Peters, Gutscher, & Scholz, 2011) as well as at tactical levels, such as decisions about travel mode (Bamberg & Schmidt, 2003; Hunecke et al. 2007; Klockner & Matthies, 2009). However, to our knowledge, no studies have related personal norms to bicycle use or to e-bike purchase.

An important finding of a recently published extensive literature review about e-bikes (Fishman & Cherry, 2015) is the considerable geographical variation in research topics. Quite a lot of research has been carried out in Asia, where e-bikes are more common; however, adopting findings from one context to another requires careful consideration of differences in legislation, culture, socioeconomic profiles, and the general transport system. Typically, the e-bikes in the Asian market are more of a "motorcycle type" than the pedelecs used in Europe. Another important trend in the existing research is that most studies have been conducted among people who have already acquired an e-bike, and only few studies investigate the differences in cycling activities between regular cyclists and e-bikers, and even fewer do this in a *prospective* manner (Dill & Rose, 2012).

Whereas e-bikes share many similarities with "normal bicycles," it is still a rather unexplored phenomenon (Dill & Rose, 2012), but scientific attention is rapidly increasing. E-bike-users are generally older than the average population (Cherry et al. 2016; Popovich et al. 2014), and have above-average income levels (Wolf & Seebauer, 2014). Many studies also report difference in distance traveled by bicycle and e-bike. For example, a Dutch study showed that e-bike users cycled on average 30 kilometers per week as compared to 18 kilometers per week for normal cyclists (Fietsberaad, 2013). Also, Cherry and Cervero (2007) found that e-bike users travel further than regular cyclists, but that they cycle a shorter time due to the increase in speed.

In Norway, one important difference between normal bikes and e-bikes is the massive differences in diffusion since some 400,000 normal bikes are sold each year, compared to approximately 12,000 e-bikes, and 77% of the population have access to a normal bicycle and only 1.4% have access to an e-bike (Hjorthol, Uteng, & Engebretsen, 2014). Hence, the vast body of research looking at psychological and contextual factors that predict bicycle *usage* (see e.g. Heinen et al. 2010) needs to be complemented with research on *uptake* of e-bikes, as this is the important first step in determining their potential effect on reducing emissions. The distinction between the strategic decision of an individual to purchase an e-bike and the more tactical decision of use choosing to use a bicycle (of whatever kind is available) fits well in with an understanding of energy product diffusion from a life cycle perspective (Hertwich, 2005), looking at a product's first-, second-, and third-order effects (Berkhout, Muskens, & Velthuijsen, 2000).

Popovich et al. (2014) reported that most participants bought their e-bikes after being encouraged by a close friend, family member, or respected community member and that the importance of experiencing e-bikes first-hand should not be underestimated in efforts to encourage e-bike adoption. Within the area of electro-mobility, the same diffusion mechanisms have been identified with battery electric vehicles (BEV): people with friends or family who own a BEV are much more likely to consider buying one themselves (Figenbaum et al. 2015). One major barrier of e-bike use is that the purchase price of e-bike is 3 to 4 times higher than that of a conventional bicycle (Tronstad et al. 2013). The price may not only be a direct barrier for purchase, but also indirectly lead to poorer diffusion, since unfamiliarity with the benefits of the e-bike (due to not knowing anyone with an e-bike) again may prevent subsequent purchase and uptake of an e-bike.

Given the many benefits of increased use of e-bikes, it is of interest to learn what the perceptions toward e-bikes are, to what extent the purchase costs are a barrier, and whether and how experience with e-bikes changes people's perceptions. Willingness to pay (WTP) is an efficient indicator of consumers' preferences and benefits. Moreover, perceptions and WTP are closely related (Ajzen & Driver, 1992; Savage, 1993) to the degree that WTP can largely be regarded as a proxy for perception—and hence that a change in WTP corresponds to a change in perceptions. Studies of WTP most often relate to non-market goods, like travel time or environmental preservation. However, WTP studies are also relevant for the study of market goods, i.e. goods that can be purchased in a market for a price. WTP is, for example, extensively used in marketing research including car customers' WTP for safety equipment (Roy Morgan Research Centre, 1992) and e-car attributes (Hidrue et al. 2011). Further, a WTP approach has particular relevance for e-bikes despite the fact that they could be purchased by anyone, since they still constitute a small niche market and are unknown to many.

Studies on fiscal incentives and WTP for e-bikes and, more importantly, on how experience from using an e-bike affects this WTP, are rare. Indeed, we are not aware of any published study that directly measures people's valuation and WTP for e-bikes. Brooks et al. (2010) found that WTP per hour for e-bikes on University of Tennessee campus was dominated by zero-WTP responses, and Jones et al. (2013) found WTP for technology improvements of e-scooters. There is an increasing number of studies on WTP for clean vehicles (see, e.g. Potoglou & Kanaroglou, 2007; Wietschel et al. 2012) and their attributes (Hidrue et al. 2011). However, WTP for e-car attributes might be a different phenomenon from that for e-bike attributes. The electric car is typically compared with a conventional car. For some, the e-bike is seen as a replacement of the ordinary bicycle (Dill & Rose, 2012), and in that comparison, the ordinary bike "wins" since it is environmentally superior and cheaper to operate. E-bike benefits, for which people may be willing to pay over and above the price of a traditional bike, are related to ease, convenience, speed, among other aspects. However, as mentioned previously, a number of studies have shown that the e-bike replaces motorized transport. Therefore, the battery is not only an attribute that is added to the ordinary bicycle, but to a large extent a different good serving a different market (Weiss et al. 2015).

It is well established that experience and knowledge of a transport mode following incentives or marketing efforts are associated with more positive attitudes, increased use, and reduced worry about their disbenefits (Donaghy, 2011). One exception to this is a recent study (Jensen, Cherchi, & Ortuzar, 2014) where an opposite tendency was identified: following a three-month e-vehicle trial, test persons chose e-vehicles less often in their stated choice experiments. However, that study did not include any control group, and it can be speculated that electric cars will perform less convincing compared to conventional cars than how e-bikes may compare to conventional bikes. It is therefore conceivable that the experience of using an e-bike will change attitudes toward e-bikes and thereby affect WTP. Among other things, WTP estimates can support the development of e-bike sponsoring schemes—like the ones that are currently in place in Paris and Oslo. Evidence of *change* in WTP is policy relevant for choosing a mix of subsidy and efforts to make e-bike features more known.

This study therefore first aims to investigate the role e-bikes can play to overcome people's barriers to cycling in Norway. Since the e-bike is still quite uncommon, it is of interest to learn what types of barriers people perceive toward cycling in general, and then to investigate whether these barriers may be overcome by an e-bike. Secondly, this study looks at one of the potential largest barriers for e-bike use—the costs of purchase—by investigating how experiencing the benefits of an e-bike influences people's perceptions toward e-bikes and WTP for one. As such, is it one of few prospective studies looking at how people's perceptions on bicycling change following an intervention using pre- and post-questionnaires with a control and an exposed group. This research design has stronger potential to relate the change of the outcome (WTP) variable to the intervention, than is the case with cross-sectional studies or retrospective studies. In other words, it allows us to make a stronger causal attribution about changes in perceptions than retrospectively asking e-bike users about how their perceptions have changed.

E-bike regulations in Norway

There is a wide range of types of e-bikes in the world market, and different countries have different sets of regulations. In Norway, e-bikes were illegal to sell prior to 2003. Since then, the country has adopted European Union's common electric bicycle requirements regarding Electric Pedal Assisted Cycle (EPACs), also denoted as pedelecs. These regulations dictate that one must tread on the pedals in order to activate the engine, that the engine performance is limited to 250 watts and that the engine cannot drive the bike faster than 25 km/h. EPACs are characterized by having pedal sensors and brake sensors. There is also a faster version of the pedelec, called the speed-pedelec, which can ride up to 45 km/h, but this is quite uncommon in Norway as it demands, among other things, a separate insurance, a license plate and a driver's license for a moped. In this study, we refer to the EPACs up to 25 km/h if we mention e-bikes. In Norway, at the time of the current study, e-bikes only represented around one percent of the annual bicycle sales (www.bike-eu.com).

Method

Setting

This study is set in the capital of Norway, Oslo, and the Akershus County, which is the surrounding area. Together, these two counties comprise 23% of the population of Norway. The area is hilly, and most urban areas typically have a town center located on flat land, and most of the residential areas being located in hills surrounding the center. In Oslo municipality, 31% of the population lives in the relatively flat inner city area.

Recruitment, participants, and procedure

The study was conducted in two stages. Stage 1—the baseline survey—was a cross-sectional data collection by an internet questionnaire, asking for perceptions about cycling, everyday transport habits, as well as recruitment questions. Stage 2 was an intervention study, in which some of the respondents were offered temporary e-bike use in order to determine the effect of using e-bikes on willingness to pay, among other things. For this, the respondents received two questionnaires, the baseline questionnaire mentioned above (pre-intervention), and a follow-up after the intervention. The test group responded to the follow-up survey upon return of e-bikes, and the control group was scheduled so that their time between baseline and follow-up matched that of the test group. Results concerning mode change from this study have been presented in another publication (Fyhri & Fearnley, 2015).

The baseline questionnaire and intervention study took place during the cycling season, which is the summer and early autumn. Cycling levels drop considerably during winter in Norway (Vågane, Brechan, & Hjorthol, 2011), and the results must thus be interpreted as limited to a context in which snow and cold weather are not strong barriers for using the bicycle.

Baseline survey

Recruitment. In June 2013, 30,000 members of the Norwegian Automobile Federation (NAF), whose membership base covers 10% of the Norwegian population, were contacted by email and invited to take part in a web survey about everyday travel. The sample was a random selection of members living in the counties of Oslo and Akershus (the region around Oslo). A total of 5,462 participants (18%) responded to the questionnaire. The study sample is not representative of the whole of Norway. However, together, it covers a mix of urban and non-urban areas representative of where 90% of the Norwegian population lives. In this context, the sample can be said to function as a "Norway in miniature" as the travel behavior pattern is the same as for the country as a whole (Vågane et al. 2011).

Survey. The baseline survey was quite extensive. In the following, we describe the items used for the current analysis in the order in which they were presented to the respondents in the survey. We aimed to measure psychological variables related to bicycle use and car use. The psychological variables measured were intentions, attitudes, personal and social norms, and habit strength. All items were developed according to general recommendations (Ajzen, 2010). Except for descriptive norms, all items were scored on a Likert scale from *totally disagree* (1) to *totally agree* (7).

Intentions were measured by two items for each behavioral outcome: "I wish to drive less car/cycle more in the nearest future," and "It is likely that I will [drive less car/cycle more] in the nearest future."

Social norms consist of the two constructs namely descriptive and injunctive norms. *Descriptive norms* were measured by one item related to each behavioral outcome: "Among people who are important for me [using the bicycle for everyday travel/using car for everyday travel] is … very uncommon (1) to very common (7)." *Injunctive norms* for cycling were measured by the following item: "People that are important to me wish that I cycle to work or school." For car driving, two items were used: "People that are important to me [do not wish that/think it is totally unacceptable if] I drive car to work or school."

Personal norms (values) related to private car use were measured according to specifications of the Norm Activation Theory (Stern, 2000). The construct *problem awareness* was measured by the following two items: "Driving is an important cause of environmental pollution"; "It has no implications for the environment if I drive car to school/work." The construct *acceptance of responsibility* was measured by the two items: "I have a moral duty not to use the car when traveling to work/school"; "I get poor conscience if I drive to work/school."

Attitudes toward everyday bicycling were assessed by eight items covering behavioral outcomes (Ajzen, 2010): "For me, using the bicycle for my everyday travel would mean…." Respondents were to indicate on a 7-point Likert scale ranging from 1 (totally disagree) to 7 (totally agree) for each of the items *low risk for accidents; mental relaxation; more freedom; time-saving; money-saving; comfort; improved condition; and the right image*. The eight behavioral outcomes were subsequently requested to be ranked in terms of their *importance for choice* (Ajzen, 2010) of everyday travel (outcome evaluation), so that each outcome was given a score from one to eight. The attitude score for each construct was calculated by multiplying the outcome score with the importance ranking score and dividing by 8 (in order to have a score ranging from 1 to 7).

Habit strength was measured with two items derived from the Self-Report Habit Index (Verplanken & Orbell, 2003). The original scale consists of 12 items, but acceptable validity can be achieved by the use of fewer items measuring the *automaticity* aspect of habits (Gardner et al. 2012) "[Using the bike/car] when I am going to work/school is something that I do without thinking about," and "Using the bike when I am going to work/school is something that I do automatically."

Barriers for using the bicycle in everyday travel were assessed by one question: "Are any of the following circumstances a barrier for you to ride your bike in everyday travel?." There were ten response items: *not good enough cycling infrastructure; it feels unsafe; (the possibility of) bad weather; too physically demanding; steep hills; need to bring children or goods; need to use the car for work; do not want to sweat/there is no shower at work; no safe parking options;* and *poor health*. The respondents were to pick a maximum of three barriers.

To measure *prior knowledge* about e-bikes, the respondents were given six statements, and were asked to indicate if they were true or false: "When using a e-bike there is no need to pedal; "e-bikes are not legal for sale in Norway"; "E-bikes are permitted only for those with physical disabilities"; "The motor on a e-bike works only when you use the pedals"; "An e-bike can achieve the same speed as a moped"; and "The motor on an e-bike recharge while braking."

There are many ways of eliciting people's WTP for private and public goods, and within economics and marketing science, hypothetical valuation methods have been developed and become more and more sophisticated in the past three decades (Carson & Louviere, 2011). Direct methods are particularly plagued by respondents who decline to state a monetary value even if they are willing to pay for a good or an attribute (Carson & Louviere, 2011; Fearnley, Saelensminde, & Veisten, 2008; Mitchell & Carson, 1989). Similar problems also occur in choice experiments (Abrantes & Wardman, 2011; Hess, Rose, & Polak, 2010). Despite this, consumer WTP exhibits some level of consistency across studies and between elicitation methods (Fearnley et al. 2008; Foster & Mourato, 2002; Veisten, 2007).

In the current study, the aim was rather to see how the intervention affects WTP rather than to establish the correct price level. We therefore adopted an approach where several less-sophisticated approaches were combined in order to achieve method triangulation, thereby reducing some of the problematic aspects of each valuation method, such as validity and reliability, biases, errors, lexicographic answering, and tendencies for overestimation (Carson & Louviere, 2011; Fearnley et al. 2008; Veisten, 2007; Venkatachalam, 2004). In the current survey, the respondents were first given this introduction: "An electric bike is a bike that has a small rechargeable battery and an auxiliary motor. The e-bike is like a regular bike, but the motor helps when you need it, such as uphill, at start-up and in

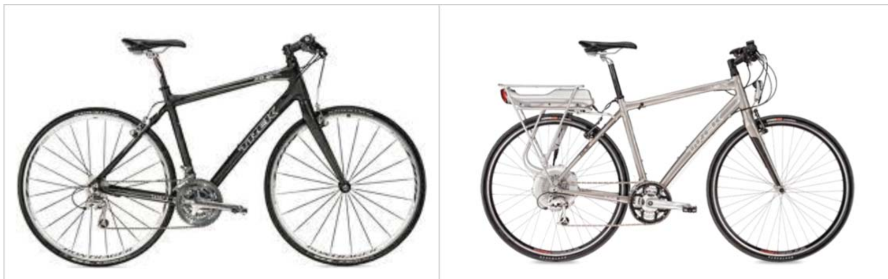

Figure 1. The bicycle images shown in the conjoint experiment. Normal bike on the left and e-bike on the right.

headwind. The top speed of the motor is 25 km/h." Then, their *willingness to purchase* an e-bike was measured with three different items.

1. "If you were to buy a bike today, would you consider an e-bike?" Possible answers were: "yes, absolutely," "yes, probably," "probably not," "certainly not," and "don't know."
2. Open-ended contingent valuation questions. [Normal bicycle]: "Imagine that you were to buy a bicycle today, how much would you maximally pay for a bicycle?" [E-bike]: "How much more would you maximally pay for an e-bike?" Recorded as Norwegian Kroner (NOK).
3. Simplified adaptive conjoint choice questions[1], where respondents were shown pictures of two bicycles on the screen, an e-bike and a normal bike, which was a hybrid bike (Figure 1). No attributes were given except type (normal/e-bike) and price. Respondents were first asked to select their preference between the normal bike at a price of NOK5,000 and the e-bike at NOK12,000. Those who chose the normal bike were then given a narrower choice between a normal bike with a value of NOK5,000 or an e-bike with a value of NOK8,000. Those who had chosen the e-bike were given the choice between a normal bike worth NOK5,000 and an e-bike worth NOK16,000[2].

The exchange rate between NOK and Euros was at the time of the survey approximately 8:1, so that the response alternatives in the conjoint-type questions amount to approximately €600, €1,000, €1,500, and €2,000, respectively. For ease of interpretation, all money values are presented in Euros, using this exchange rate.

For the analyses, WTP for an ordinary bike was added to WTP extra for an e-bike to form the measure *total willingness to pay for an e-bike*. The measure *conjoint WTP* was computed based on the choice questions, by assigning those not willing to pay anything extra for an e-bike the value €600. Those willing to pay €1,000, €1,500, or €2,000 were assigned these values.

Intervention study

Recruitment. Toward the end of the baseline survey, respondents were asked to indicate if they were interested in trying an e-bike for a few weeks. 1,425 of the participants said yes. Of those interested, $n = 220$ were randomly selected to be part of the intervention group. They were invited by e-mail to participate and borrow an e-bike. 61 individuals (30%) finally borrowed an e-bike and answered a questionnaire, and were therefore consequently subjected to the intervention. The remainder of the willing participants ($n = 1205$) were selected to be in the control group. Of these, 214 (18%) responded to the follow-up questionnaire. A flow diagram of participants is presented in Figure 2.

Intervention. The intervention took place between 28 July and 17 October 2013. Intervention participants were invited to take part at those time intervals that best suited their own stated availability. They were invited to test the bike for either 2 weeks ($N = 55$) or 4 weeks ($N = 11$).

The electric bicycles could be collected at a specialized e-bike dealer in Oslo, which was easily accessible by public transport. Prior to arrival, the participants were asked about preferred type of frame (Ladies' or Gent's) and size. The bikes used were of the brand BH Emotion (NEO Cross/City), and were all approved pedelecs (according to EU/Norwegian standards). The trial participants were instructed how to operate the e-bike and that the bike should be used only by themselves (except for short trial trips by family and friends). No further instructions were given. On average, the bicycles were used for 6.9 km per day in the trial period, according to the bicycles' built-in odometers. The participants were asked if anyone else had used the bicycle, and how much (in percent) others had used it. Half of the participants had let others try the bicycle, but based on self-reported use, this only amounted to a small fraction of total usage (mean value 5.5%).

Survey. In the second questionnaire, respondents who had used an e-bike were first asked about their experience of using an e-bike and for what purposes the extra power from the electric motor was mostly used. The respondents were given six items: *cycled longer; more speed flat ground; more speed up hills; cycled hills you usually would not climb; cycled with luggage; cycled as before but with less energy*, and *less sweating*, and were asked to indicate on a 7-point Likert scale ranging from 1 (to a very small extent) to 7 (to a very large extent). They were also

[1] More correctly, we use the Frisch elicitation method, named after the 1969 Nobel Prize laureate Ragnar Frisch (Frisch, 1972). See Fearnley et al. (2008)

[2] Prices were selected so as to represent the average price for an ordinary bicycle (NOK5,000); the lowest available price for an e-bike (NOK8,000); a cheap/decent quality e-bike (NOK12,000); and the average price for an e-bike (NOK16,000), in the Norwegian market, according to communication with dealers.

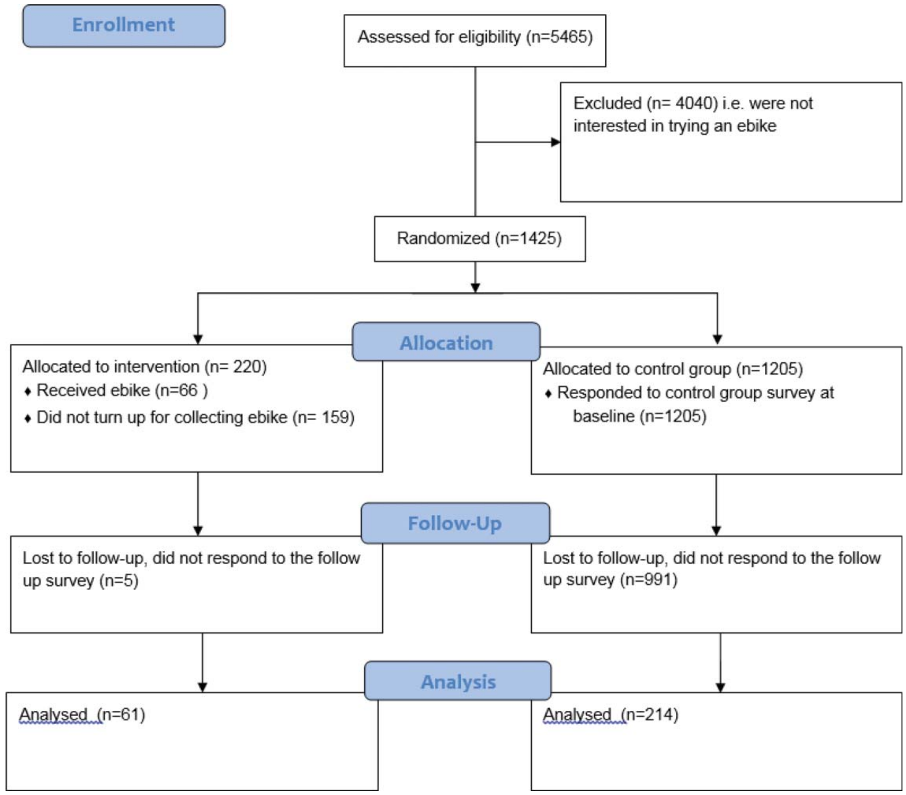

Figure 2. Consolidated standards of reporting trials (Schulz, Altman, & Moher, 2010) flow diagram showing the number of participants in trial and control groups, enrollment, treatment allocation, follow-up, and analysis.

asked if they had any reason for not purchasing an e-bike: "Are some of the following conditions a barrier for you to buy an e-bike?"). The respondents were given seven items: *price; not sure I will use it; afraid that it might be stolen; infrastructure poorly adapted; I do not get enough exercise using an e-bike;* and *the e-bike does not fit my image*, and were asked to indicate on a 7-point Likert scale ranging from 1 (a very small barrier) to 7 (a very large barrier).

Various indicators measuring the effect of the e-bike on daily cycling and transport were also collected, but will not be reported here, as they have been reported elsewhere (Fyhri & Fearnley, 2015).

Toward the end of the survey, the questions on WTP of the baseline survey were repeated.

Participants

Table 1 presents an overview of the background variables for the test group, the control group, those interested in trying an e-bike, the total survey sample, and the Oslo/Akershus population as a whole (retrieved from Hjorthol et al 2014).

One-way between-group analyses of variance (ANOVAs) were conducted to test whether differences between willing participants and the total sample, as well as between participants and the control group, were statistically significant. Willing participants tend to be higher educated, younger, have a higher employment rate, cycle more, and have a higher intention for increased cycling in everyday life than the total sample. The test group, i.e. those who actually turned up to borrow an e-bike, differed significantly from the control group in that they

Table 1. Background characteristics of those willing to participate in the intervention, test group (after drop-out), control group (after drop-out), and all participants in recruitment survey.

	Test group[1]	Control group[1]	Willing to try e-bike	Total sample	Oslo/Akershus
% 65 years old or above	11	9	14***	19	17
Mean age	47	46	49***	52	44
% Female	34***	27	30***	31	50
% Employed	92	91	82***	78	72
% Above 700 000NOK (88€) annual income	18***	28	24	25	16
% University education, or equivalent	82	86	67***	71	68
Mean distance to work/school[2]	15.0	15.7	18.0	18.8	22.8
% Cycled on day of interview	28**	22	17***	12	9
Intentions to cycle more (score 1–7)	4.5	4.7	4.4***	3.9	
N	*61*	*214*	*1425*	*5462*	*4073*

[1]After dropout.
[2]Only asked for those in occupation/education, n = 4164.
$^{**}p < 0.01$. $^{***}p < 0.001$.

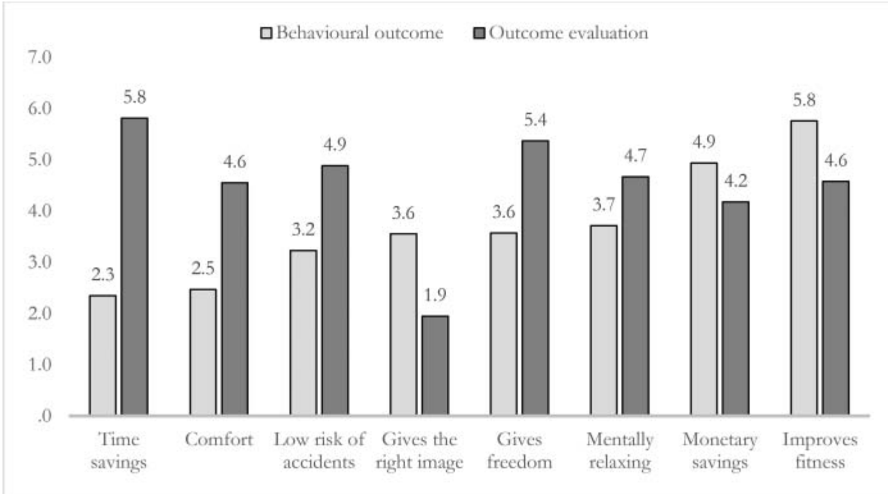

Figure 3. Attitudes (behavioral beliefs) to cycling in everyday life. Behavioral outcomes (average score on a Likert scale from 1 to 7 (1 = not important at all, 7 = very important) and outcome evaluations (ranked assessment score from 1 "least important" to 8 "most important"). N = 5460.

were more evenly gender balanced, had a lower income, and cycled more.

Results

Baseline survey

All respondents in the baseline survey were asked to identify main barriers of cycling in everyday life ($N = 5460$). The most often mentioned barriers were that the cycling infrastructure was not good enough (46%) and that cycling feels unsafe (40%). The possibility of bad weather was the third (34%). In fourth and fifth places, we find obstacles that the e-bike potentially can overcome, that it is physically demanding to use a bicycle (22%), and that there are steep hills (18%).

Figure 3 shows the respondents' attitudes toward everyday bicycling, presented as assessments of the eight statements and their average ranked importance (possible values 1 (least important) to 8 (most important)).

The aspect of the bike, which people are most positive toward, is that it helps to *improve fitness*. This is also a factor that is highly ranked for importance for travel choice. A closer look at the rankings shows that respondents are fairly divided in their views on this question: 32% gives *improves fitness* the value 7 or 8, and 30% gives it 1 or 2. *Saving money, being free*, and *mental relaxation* are also positive aspects of the bike. At the other end of the scale, we see that the bike scores low on *saves time* and *comfort*. In particular, *saving time* is important for people, and is the aspect most have put on top of their list. Over half placed this outcome as number 7 or 8 (average score 5.8).

The interest in purchasing an e-bike was measured by the item "If you were to buy a bike today, would you consider an e-bike?." Six percent responded "yes, absolutely," 23% "yes, probably," 30% "probably not," and 37% "certainly not." Figure 4 shows the percentage of respondents who were willing to purchase an e-bike according to weekly cycling distance for transport.

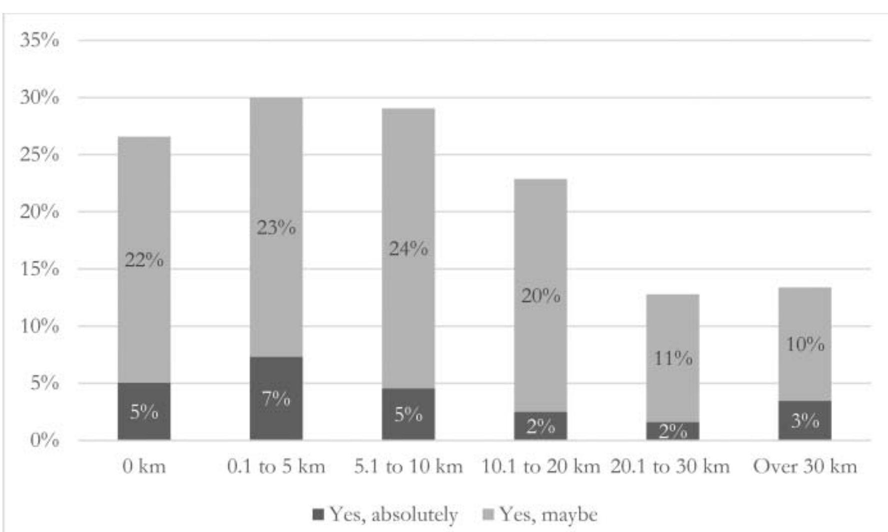

Figure 4. Interest in buying an e-bike according to weekly cycling length. Percent "yes, absolutely" and "yes, maybe" N = 3263.

Table 2. Scores on the knowledge index versus self-reported knowledge. Mean scores (ranging from −6 to +6).

	Score on knowledge index	N (%)
Nothing	1.18	1582 (33)
A little	2.77	1711 (35)
Some	3.39	1328 (27)
Much	3.62	198 (4)
Very much	4.17	46 (1)
Total	2.47	4865 (100)

The highest interest for purchasing an e-bike existed among those who cycled up to 10 km per week. The lowest interest could be found among those who had cycled more than 20 km (13% interested). Those who had not cycled at all were slightly less interested in purchasing than those who had cycled a little.

In order to check our respondents' state of knowledge about e-bikes, they were given six statements about e-bikes, and were asked to indicate if they were true or false. Most of the statements were correctly answered, but only 18% knew that the motor is only activated when pedaling, and 33% thought (wrongly) that the motor is recharged by braking. Number of correct and wrong answers was summarized into a knowledge index with −6 as the lowest score, and +6 as the highest. Twenty-two percent of the respondents scored zero or less than zero, 7% achieved the top score. Table 2 shows scores on the knowledge index versus self-reported knowledge, ranging from "nothing" to "very much." Thirty-three percent of the respondents said they knew nothing about e-bikes, and a further 35% said they only knew a little.

Those who claimed to know nothing about e-bikes scored the lowest (1,18), and those who claimed to know very much scored highest (4,17). There was a moderate correlation between self-reported knowledge and score on the knowledge index ($r = 0.44$, $p < 0.01$).

Table 3 shows the mean scores on the sociopsychological values according to interest in buying an e-bike. One-way between-group ANOVAs were conducted to test if differences between participants with different interest in buying were statistically significant. The summary (F-scores and *p*-values) is displayed at the right of the table.

Those willing to purchase an e-bike have significantly weaker habits for cycling, lower perceived behavioral control, lower intentions for cycling more, less positive attitudes toward cycling, and less social support for cycling than those who are not interested. There are also significant effects of moral norms in the form of problem awareness against car use and intentions to drive, but these effects are small. The moral norms related to acceptance of responsibility to do something about environmental problems did not predict interest in purchasing an e-bike.

In order to test which variables could predict interest in e-bikes, we conducted an ordinal regression (SPSS PLUM) with *interest in buying* as dependent variable. Respondents who had answered "don't know" ($N = 238$) were removed from the analysis. Table 4 summarizes the results of the analysis.

As a preparation for the modeling, a range of variables were tested for bivariate correlations with the dependent variable (Tabachnick & Fidell, 2007). Through this process, the following variables were excluded, due to zero correlation with the interest in purchasing an e-bike[3]: Income level, having children in the household, usual travel mode to work, distance to work, personal norms against driving cars, and gender.

Independent sociodemographic variables included in the model were age (19–94 years) and education level (4 levels from compulsory to university degree). Transport-related variables were weekly distance cycled for transport (0–724 kms) and weekly distance cycled for exercise (0–700 kms). E-bike-related variables were knowledge about e-bikes (5 levels from "nothing" to "very much") and willingness to pay for a normal bike (0–99000 NOK). Sociopsychological variables were attitudes toward cycling, intentions to cycle more, intention to drive less cars, social norms for cycling, perceived behavioral control, and habit strength for cycle use (all scored from 1 to 7).

The estimates provided above are the ordered log-odds estimates, and their interpretation is dependent upon the units used for the dependent variables. Since the variables are measured with different units (e.g. knowledge is measured with five scores from lowest to highest, whereas WTP for normal bike ranges from 0 to 99 thousand NOK), it is not straightforward to interpret their relative contribution. The Wald statistic can be used as proxy for this.

The strongest predictor for *interest in buying* an e-bike is knowledge about e-bikes. The second most important variable is WTP for a normal bike, which has a negative influence on interest in buying an e-bike; in other words, those who are willing to pay much for a normal bike are less likely to want an e-bike. Habit strength for cycling, having higher education, cycling a lot for transport, or exercise all contribute negatively to interest in e-bikes. Those who have intentions to drive less car in their everyday life are more inclined to want an e-bike. Age, attitudes toward cycling, intentions for cycling more, and social norms for cycling were not significant.

Those who were in employment or in education ($N = 4178$) were asked about their mode of transport the last time they traveled to their job or place of education. The respondents who had not been against considering to buy an e-bike ($N = 3080$) were asked an open-ended contingent valuation how much they were willing to pay extra for an e-bike compared to a regular bike (WTP question number two). Thirty-one percent of the respondents were not willing to pay anything extra. On average, the respondents were willing to pay a maximum of €215 (€327 when zero responses are excluded) more for an e-bike. This corresponds with a price premium of about 27% compared with WTP for an ordinary bicycle of €775.

To test if WTP for normal bike influenced WTP extra for an e-bike (WTP # two), a one-way between-groups ANOVA was conducted. Participants were divided into three groups according to their WTP for an ordinary bicycle: Low = 0–4999 NOK ($N = 1000$); Median = 5000–8999 NOK ($N = 981$); High = 9000 NOK and above ($N = 352$). The respondents who were not willing to pay anything extra (31%) were not included in the analysis. There was a significant *positive* effect of WTP for an ordinary bicycle on WTP for an e-bike ($F(2, 2330) =$

[3]A model where these variables were included was also tested, and the parameter estimates did not differ substantially from the existing model

Table 3. Mean scores on habits, perceived behavior control, intentions to cycle more, attitudes, social norms, personal norms (two constructs), and intentions to drive less car for respondents with different levels of interest in buying an e-bike. F-scores and p-values (N = 4865).

	Yes, absolutely	Yes, maybe	Don't think so	No. certainly not	Don't know	Total	*F*	*p*
Habits	2.2	2.2	2.6	3.2	2.4	2.8	26.7	< .001
Perceived behavioral control	3.4	3.4	3.7	3.9	3.2	3.7	20.9	< .001
Intention to cycle more	3.7	3.7	4.0	4.1	3.3	3.9	15.4	< .001
Attitudes	2.0	2.0	2.1	2.2	1.9	2.1	12.9	< .001
Social norm for cycling	2.7	2.8	2.9	2.9	2.5	2.8	5.0	.001
Personal norms, problem awareness	5.2	5.1	5.3	5.2	4.9	5.2	3.9	.003
Intention to drive less car	3.2	3.0	3.1	2.9	3.1	3.0	2.5	.044
Personal norms, acceptance of responsibility	3.1	3.3	3.4	3.9	3.7	3.3	0.7	.563

Table 4. Ordinal regression with dependent variables "interest in purchasing an e-bike" (absolutely not, probably not, yes possibly, yes absolutely).

		Estimate	Sig.	Wald
Threshold	Probably not	−1.03	< 0.001	12.612
	Yes possibly	0.55	0.06	3.587
	Yes absolutely	2.57	< 0.001	70.361
Location	Knowledge about e-bikes	0.36	< 0.001	63,42
	WTP for ordinary bike. 1000 NOK	−0.01*	< 0.001	56,09
	Intentions to drive less car	0.10	< 0.001	15,97
	Habit strength for cycling	−0.12	< 0.001	15,69
	Cycling for exercise. kilometers	−0.01	< 0.001	12,76
	Education level (high)	−0.17	< 0.001	11,57
	Cycling for transport. kilometers	−0.01	< 0.001	11,35
	Perceived behavioral control	0.01	0.01	7,50
	Age	−0.01	0.11	2,60
	Attitudes to cycling	−0.01	0.13	2,33
	Social norm for cycling	0.03	0.69	1,01
	Intentions to cycle more	−0.02	0.40	0,70
	Nagelkerke R2	0.14		

*The not-rounded parameter estimate is 0.00005.

114.335, p < 0.001). Post hoc comparison using the Tukey HSD test (homogeneity of variance was initially confirmed using Levene's test) indicated that all groups differed significantly from each other in their WTP for an ordinary bicycle (Low: M = 204€, SD = 226€, Median: M = 344€, SD = 304€: High: M = 591€: SD = 868€). To sum up, the results of the ANOVA show that those who were willing to pay much for an ordinary bike are willing to pay more for an e-bike if they are to buy one.

Table 5 shows travel mode on last trip to work, and WTP for a normal bicycle and WTP extra for an e-bike according to the existing travel mode.

The car was by far the most common mode of transport (62%), followed by public transport (25%). Only 6% of these respondents had traveled by bicycle for their last trip to work.

Those who walk have the lowest (652 €), and existing bicycle users have the highest (1,202 €) WTP for a normal bike. A one-way between-group analysis was conducted to test if current mode of transport could influence WTP for ordinary bicycle and e-bike. Post hoc comparison using the Tukey HSD test (homogeneity of variance was initially confirmed using Levene's test) indicated that existing bicyclists differed significantly from the others in their WTP for an ordinary bicycle. There were no significant differences between other groups. The differences in extra WTP for an e-bike seem to be smaller, and the ANOVA confirms that the differences are not significant.

Table 5. Willingness to pay for a normal bike and extra for an e-bike according to travel mode on last trip to work. Unit = 1 €. (N = 2420).

	WTP normal bike (€)	WTP more for E-bike (€)	N (%)
Car	756	202	1501 (62%)
MC/moped	773	233	56 (2%)
Bike	1202	245	140 (6%)
Walk	652	226	109 (5%)
Public transport	785	237	614 (25%)
Total	785	215	2420 (100%)

Follow-up survey

Upon returning their e-bike, the intervention group participants were first asked about their user experiences. Most of the participants (72%) had used the bike primarily for work commute trips. A majority (77%) stated that the e-bike had made them cycle more often than before, and 56% said that the bike allowed them to ride longer trips than before.

Figure 5 shows how participants had taken advantage of the extra power from the electric motor. The most common utilization was to ride faster uphill (mean score 6.6). The second way it was exploited was to cycle as before, but with less energy consumption (mean score 5.7). There were only a few who had taken advantage of the bicycle to carry extra luggage (mean score 2.5), and to ride faster on flat ground (mean score 4.4).

Price was the only hindrance to buy an e-bike that was given any substantial mention (mean score 5.0). There was also some concern that it might be stolen (mean score 4.0).

Table 6 shows our sample's average WTP as measured with three different measures before and after the intervention period. Only participants who responded to the WTP questions in both surveys are included. Extra WTP represents what participants are willing to pay above the price of an ordinary bike in the contingent valuation experiment. The indicator "Total WTP for e-bike" is the total of WTP for ordinary bike plus extra WTP for e-bike.

In order to test if the WTP was affected by the intervention, one-way repeated measured ANOVAs were conducted, comparing the difference in WTP between test and control groups before the intervention with the difference after the intervention. The analyses of all three WTP measures showed that both groups had an increase in their expressed interest in buying an e-bike, but that the test group had a significantly higher increase in WTP compared to the control group. In the test group, extra WTP for e-bike increased €190 from €322 to €512 as a result of the intervention, whereas the control group

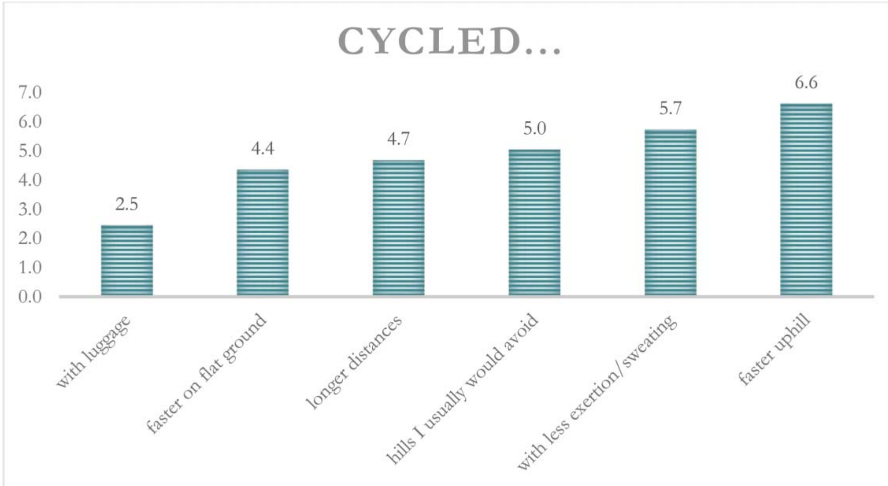

Figure 5. How participants had taken advantage of the extra power from the electric motor (N = 61). **1** = to a very small extent; **7** = to a very large extent.

increased their WTP with €79, the difference between €190 and €79 (€111) is significant [F(1.207) 6,67 $p = 0.010$]. *Total* WTP for e-bike increased with €297 in the test group and only €26 in the control group. This difference (€271) is significant [F(1.207) 3.364 $p < 0.068$]. This was due to the test group increasing their WTP for a normal bike, whereas the control group actually decreased it. Conjoint WTP for e-bike increased with €153 in the control group, and €422 in the test group. Also, this difference (€269) is significant [F(1.207) 11.03 $p < 0.0001$]. To sum up, for all elicitation methods, the intervention increased WTP for e-bikes significantly more for the test group than for the control group.

Discussion

Below, we discuss the results of baseline and intervention study as well as strengths and limitations.

Baseline survey

The results from the baseline survey showed that participants' perceived barriers against bicycling were mostly related to factors that the e-bike could *not* alleviate, such as poor infrastructure and feeling unsafe. Still, around one-fifth of the participants mentioned factors such as physical demand and hilliness, and for these, an e-bike would be an obvious solution for increased bicycling. Also, for the average participant, cycling scored low on time use and comfort. To the extent that an e-bike can improve these two aspects, it is a promising tool for increased bicycle use. We found that the population in this survey were divided into three groups: around one-third were interested, one-third doubted, and one-third were opposed to buying an e-bike. Only six percent were committed to the degree that they said they definitely would consider an e-bike. The fact that those who cycle the least are most interested in buying an e-bike may be an indication that the e-bikes are unlikely to lead to a large reduction in normal cycling, but that they are more likely to result in shifting people away from motorized transport, or generate increased mobility.

On contrary to popular assumptions, few studies have actually showed an influence of knowledge on behavior change. In health psychology, studies have found weak (Sheeran & Taylor, 1999) or insignificant (Ananth & Koopman, 2003) effect. In the domain of environmental studies, results are also mixed (Ajzen et al. 2011), but some studies indicate a positive effect (Flamm, 2009). In the current study, a positive *indirect* effect is suggested, as we see that knowledge influences the desire to buy an e-bike. These results are only suggestive, as we have not recorded their subsequent purchasing behavior, and we do not know the direction of causality (it might be that people who are positive to e-bikes have acquired more knowledge). Still, we can speculate that in a country such as Norway, where e-bikes still are quite rare and people have limited knowledge (as was shown in the current survey), an important task for those who want to use the e-bike as a tool for increased bicycle use is simply to spread experience and knowledge among the wider population.

The results of the ordinal regression analysis show that the e-bike is of little interest to those who already cycle much, or who had intentions to cycle more, but it still appealed to those

Table 6. Willingness to pay extra for an e-bike, total willingness to pay for an e-bike, and conjoint-type measure of willingness to pay for an e-bike in the test group and control group before and after the intervention.

	Extra WTP for e-bike €		Total WTP for e-bike €		Conjoint WTP e-bike €	
	Control	Test	Control	Test	Control	Test
Before	283	322	1 248	1 309	1 038	1 042
After	361	512	1 274	1 606	1 191	1 465
Change	79 (28%)	190 (59%)	26 (2%)	297 (23%)	153 (15%)	422 (41%)
N	123	56	123	56	123	56

who wanted to drive less car (when controlling for cycling intentions). Interestingly, those who were willing to pay much for an ordinary bike are less interested in buying an e-bike. On contrary to this, the results of the ANOVA show that those who were willing to pay much for an ordinary bike were willing to pay more if they were to buy an e-bike. These slightly conflicting relationships have to be understood in light of a particular Norwegian cycling culture, which is typical as well for many other countries with low cycling levels. Compared to countries with higher cycling shares, Norway has a much larger proportion of training-oriented and highly equipped cyclists (i.e. tend to have a high WTP for sports equipment), who also tend to be men, often denoted as "lycra-cyclists" (Fyhri, Bjørnskau, & Backer-Grøndahl, 2012) due to their outfit. For this (large) subgroup of the cycling population, an e-bike is counter to their motivation for cycling: that it provides exercise. This interpretation is supported by the fact that *improved fitness* was the benefit from cycling that to the largest extent divided the participants in the current survey. People tended to either think of this as important or unimportant for their decision about travel mode, and quite rarely as of middle importance. Related to this, there were no differences according to the existing travel mode to work in people's WTP for an e-bike.

On contrary to previous studies about pro-environmental behavior (e.g. Bamberg & Schmidt, 2003; Klockner & Matthies, 2009), neither personal (integrated, moral) nor social (peer pressure) norms predicted interest in buying an e-bike. It should be noted that these variables were measured with fewer items than what is normally done, which might have influenced the results. However, it is also likely that the finding is valid. The personal moral norms in the survey were related to environmental protection, and the social norms were related to cycling more or driving less car. Given that e-bikes are still quite new to the Norwegian market, and knowledge about them is quite limited, it is quite likely that the respondents do not see the potential link between purchasing an e-bike and cycling more and the subsequent potential environmental benefits resulting from this.

The regression model explained a small part of the variance in participants' interest in buying e-bikes. This is not uncommon for survey data from population surveys.

The variables included were partly theoretically derived (TPB and personal norms), and partly of a more applied nature (such as WTP for a normal bicycle and travel behavior). Due to restrictions in interview time, we could not fully account for the theoretical models. Further, we did not attempt to conduct a path model where e.g. intentions are first predicted (mediated) by social norms and attitudes, before they predict behavior. One important reason for this was that the behavioral outcome (interest in buying an e-bike) is not a direct successor to the measured TPB variables (more cycling/less car driving), and it would therefore not make theoretical sense to conduct a mediator model.

Intervention study

The results of the intervention study showed a large increase in participants' WTP for an e-bike after having had access to use it for some weeks compared to the control group. It should be noted that also the control group had an increase in WTP during the study period. The reason for this increase is unknown, but one likely candidate for an explanation can be a priming effect, i.e. that taking part in the first survey had somehow triggered control groups respondents to think more about the e-bike as a viable alternative for their everyday travel. Another explanation could be that there had been an increase in mention of e-bikes in national media during the period. In any case, the design of the study (with a test and control group) made sure that these external factors were controlled for, and we could see a significant difference in the rate change for WTP.

In the current study, the aim was not to elicit the correct price level but to observe how WTP changed following the intervention. With these limitations, we observe that Norwegians are prepared to pay a substantial price for their ordinary bicycles. Our survey suggests an average of around €1,000, which is only a little less than the starting price of an e-bike of reasonable quality in Norway. Although e-bikes appear expensive for some uses and for some target groups, they do not cost considerably more than what people in the sports/exercise segments pay.

There was a significant effect of having access for multiple weeks to an e-bike on participants' WTP for one. All three measures of WTP (extra WTP, total WTP, and conjoint WTP) increased significantly in the test group. These increases were in the range of €190 to €422, which was significantly more than those in the control group (ranging from €79 to €153) so that the net effect of the intervention (i.e. controlling for change in WTP that occurred in the control group) was an increase in WTP of between €111 and €271. Consequently, we believe that we have observed real changes in people's stated willingness to purchase an e-bike as a result of the intervention. In the e-bike business, the smile-on-the-face effect of someone trying an e-bike for the first time is well known (Tronstad et al. 2013). This effect has been cited as one of the major factors for the relatively strong position of the e-bike in a country such as Switzerland, where government-sponsored road shows have been going on for several years (Tronstad et al. 2013). The current study gives empirical backing for such a claim; letting people try an e-bike appears to be a simple but effective strategy to get more people to buy them, and subsequently to get more people to use bicycles on their daily travels.

Strength and limitations

The strengths of the current study include the large sample size, and a sample that is fairly representative for the Norwegian population in terms of travel patterns (with some limitations—see below). In addition, in contrast to more commonly conducted cross-sectional surveys, we have supplemented survey data and conducted an intervention study with pre- and post-measurements. This enabled us not only to provide cross-sectional findings about associations, but also being able to control in a better way than cross-sectional studies for causality. The controlled design enabled us to identify causal and net effects of the intervention.

Our findings must be interpreted with some caution, as our study has shortcomings. Although the baseline sample size is large, our intervention group only counts 66 persons. As such, this is not a small sample size for an intervention design, and the WTP effects are substantial enough to be significant even with this number of participants. However, there was a considerable dropout from recruitment to actual participation, which might have influenced the results. The 66 people who participated in the trial had lower income, shorter average travel distance, and cycled more at baseline than the sample they were randomly drawn from (the 1425 willing participants). Participants were *ipso facto* more motivated to try the e-bike than abstainers. It could also thus be speculated that this self-selection might be a challenge for the external validity of the results, since participants would be more motivated than the abstainers to take the e-bike into use, once they had received it, and thus may also have a more positive experience of the e-bike as a function of the intervention. There were no baseline differences in terms of intentions to cycle more between participants and abstainers (control group). If participants' responses are to be taken at face value, this should indicate the same level of motivation for behavioral change (more cycling) among test people and abstainers.

Still, it cannot be ruled out that the intervention group may have felt an obligation to report a higher WTP as a form of reciprocity for having been gifted free use of an e-bike for several weeks (an experimenter - demand effect). It is not likely that respondents remember their own responses from the first to the second survey, so this would have to be more of an unconscious or subconscious process. Whether the expressed WTP actually results in subsequent changes in purchasing behavior is a matter for future research.

It could be argued that asking people directly about the benefits of an e-bike would have been a more straightforward way of accessing information about its potential for transport mode changes. However, as we have shown in the current study, the population of Norway has restricted knowledge about e-bikes. Asking about the benefits of an e-bike in such a context would give little valuable insight, whereas asking how they have deliberated about cycling in general informs us about the gap in the market that e-bikes can help fill.

Unfortunately, some crucial characteristics differed between the test group, the total sample, and the control group. Our study therefore suffered from some degree of self-selection and from a biased sample despite a randomized design. The results must be interpreted with this in mind. The test group (willing participants) cycled more, had higher employment levels, higher education, more women, and a lower mean age than the total sample. The most crucial difference related to the interpretation of the results is in fact between the test group and the control group: the former cycled more and had a lower income level. There was also a gender difference, but this was not large enough that we believe it gives a substantial contribution, even if it was statistically significant. From previous research, we know that e-bikes tend to have a *larger* appeal among those who cycle the least (Fyhri & Fearnley, 2015). Hence, the observed baseline differences in existing cycling levels in the current study should not be detrimental to the observed effects of an e-bike. Still, we cannot be entirely sure that we would have observed the same changes in WTP if the participants of the control group also had been given an e-bike, given that they also differed in income levels (and gender).

The recruitment of participants was based on a sample of members of a car owners' association (NAF). The main reason for using this sample was partly convenience and to have as close to a representative sample of Norwegian residents as possible: the survey was to be conducted as a web-survey, and NAF has the largest collection of available email-addresses in Norway. The aim was to have as close to a normal population representing the e-bike market as possible. It could be argued that using census data, or phone registries, would capture a more general population, but participants would then have to be contacted via postal mail or phone calls. Experience shows that dropout to web-surveys then increases considerably, which would have led to far larger problems with generalizability than what was encountered in this study (Deutskens, de Ruyter, & Wetzels, 2006).

The people that were recruited were not real e-bike owners. Even though this approach has its obvious advantages, being an experimental design, it suffers from some limitations regarding its ecological validity. The participants are placed in a somewhat artificial situation and they were not to keep the bikes after the intervention period. Any response on perception about bicycling would therefore be colored by this knowledge. Hence, the design does not allow for testing the effect of the e-bike on changes in attitudes to cycling, perceived behavioral control, or habit strength for cycling (initial analysis revealed no significant changes). Future research should therefore study purchasers of e-bikes, in the same controlled manner, thus giving the opportunity to study the effect the e-bike has on people's perceptions about bicycling. Such a study would provide useful insights into the role of the e-bike in moving people from motorized to non-motorized travel. From an academic point of view, such a study would be of great interest as it unravels some of the chicken-and-egg problems of cross-sectional studies and provides better knowledge about how people's attitudes are formed by their behavior.

The study is performed in Norway where the e-bike market is expected to take off in a near future, and should be interpreted in that context. Further to that, Norway is a developed country, where the population demographics, travel patterns, and transportation issues are vastly different from those in many of the developing countries where e-bikes have shown the strongest emergence, and where much of the existing research on e-bikes has been conducted. It is likely that similar results are obtained in countries with similar characteristics, most notably with similar cycling levels. So, in this respect, the current study gives a nice picture of the situation of quite a number of different countries, but the results are may be less applicable for countries where the e-bike already has a strong market position.

Conclusions

This paper presents the results of an intervention study where test participants from Greater Oslo were given an e-bike for a limited duration of 2–4 weeks. The test group and control group were examined prior to and after the test period.

The results show that those who cycle the least are most interested in buying an e-bike. Therefore, the e-bike is unlikely to lead to a large reduction in normal cycling, but rather shifting people away from motorized transport, and generally increase people's mobility.

While it is expected that e-bikes in particular reduce problems of hilliness and of physical strain as barriers to cycling, these barriers were only considered to be of medium importance by respondents. Quite a number of the participants held attitudes toward everyday cycling that were indicative of the bicycle as a tool for improved health, thus not being responsive to the e-bike as a tool for increased cycling. The results showed that men and those who wanted to pay much for a normal bicycle were less interested in buying an e-bike. However, the high number who were interested in trying an e-bike suggests that there still was a substantial proportion for whom the e-bike clearly has a potential of shifting them over to active travel.

Those who had taken part in the intervention stated that they had used the extra power from the motor to cycle faster, also uphill, and longer distances while avoiding getting sweaty. However, the e-bike did result in transporting more luggage.

Stated WTP for an e-bike increased substantially as a result of the intervention. WTP is an indicator of welfare and benefit. The fact that it increased considerably as a result of the intervention suggests that people are unaware of benefits associated with e-bikes. In countries where e-bikes have not yet taken a strong market position, spread of knowledge and letting people try an e-bike can be an effective strategy to get more people to buy them, and subsequently to get more people to use bicycles on their daily travels. The relatively high purchase price of e-bikes is a considerable barrier to many people, and price reductions may boost market uptake. Sales tax exemption, which is already in place for battery electric cars in Norway, is one way to achieve this.

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