ScienceDirect

Transportation Research Part A: Policy and Practice
Volume 180, February 2024, 103974

Cost-benefit assessments of an e-bike subvention programme in Oslo, Norway

Knut Veisten, Aslak Fyhri, Askill Harkjerr Halse, Hanne Beate Sundfør

Institute of Transport Economics (TØI), Gaustadalléen 21, NO-0342, Oslo, Norway

Received 29 September 2022, Revised 19 December 2023, Accepted 7 January 2024, Available online 19 January 2024, Version of Record 19 January 2024.

Show less

Outline | Share | Cite

https://doi.org/10.1016/j.tra.2024.103974
Get rights and content

Abstract

In an attempt to increase the bicycle share in transport in Oslo, the municipality launched an e-bike subvention programme in 2016. One thousand persons were to receive a 20% subvention if they bought an e-bike, by registering via a municipal webpage on a first come first served basis. Nearly 700 ended up buying a subsidised e-bike. A connected research project surveyed subvention recipients and non-recipients, including registration of daily transport by cycle/e-bike, walk, car, and public transport, before the programme took effect, with a similar surveying after most of those qualifying for subvention had bought their e-bike. In this paper we assess the effects of the e-bike subvention in a cost-benefit analysis.

The cost-benefit analysis compares the cost of carrying out the e-bike subvention programme against the benefits due to transport mode shift and increased active travel. The benefits, the changes in monetised external effects, comprise two main elements: the health effect from active travel and the congestion, emissions, etc. caused by cars and larger vehicles.

Differently from former studies, we take into account that transport mode changes following from a bicycle project will normally not imply only shift from private car to bicycling, but also shifts from walking and

public transport to cycling. Moreover, some of the negative external effects from private cars and public transport vehicles are already internalised via taxation and can be deducted from the calculations.

Our ex-post assessment of the implemented e-bike programme indicates that the benefits in the year of implementation probably surpassed the costs of the programme. The benefit calculation was relatively robust to alternative assumptions for the road transport (the share of electric cars, the occupancy in public transport, and the share of congested travel), but relatively less robust to altered assumption about the active travel. However, if there is an impact of the e-bike subvention programme beyond the implementation year, we have underestimated the benefits.

Previous

Next

Keywords

External effect; Health; Internalize; Mode shift

1. Introduction

The focus on active transport and cycling has been increasing; and researchers and policymakers have been searching for efficient policies that can increase cycling shares (Pucher et al., 2011, EU ministers for Transport, 2015, Kornas et al., 2017, Winters et al., 2017; Gerike et al., 2019; Hunkin & Krell, 2019). In this study, we investigate whether subvention policies for increasing cycling can be an economically efficient policy.

In Oslo, the capital of Norway, the cycling share was about 8% in 2014 (Hjorthol et al., 2014); the share has not increased in the following years (Lunke and Grue, 2018, Grue et al., 2021). In January 2016 the Oslo City Council launched an e-bike subvention programme, inviting citizens to register on a web page for a 20% subvention of the purchase price of a new e-bike.[1] The maximum subvention amount was 5000 Norwegian kroner (NOK), or approximately 500 EUR. Thousand individuals could register at the webpage, selected according to a first come first served criterion. The quota of 1000 was reached in short time and about 70% of these individuals ended-up buying a subsidised e-bike (Sundfør & Fyhri, 2022).

We assess the e-bike subvention programme within a cost-benefit analysis (CBA, see, e.g., Dasgupta and Pearce, 1972, Mishan and Quah, 2020), comparing the benefits from the estimated transport mode change against the costs of planning and executing the programme. The benefits are measured as monetised changes in external effects. These external effects comprise two main elements (Börjesson & Eliasson, 2012):

i) the health effect from cycling and

ii) the negative external effects from motorised transport.

While former CBA studies have presented schematic analyses assuming a certain shift from car driving to bicycling (Rabl and de Nazelle, 2012, Gössling and Choi, 2015), we base our CBA on a controlled before-after study of a specific (non-infrastructure) bicycle measure. This implied that both subvention recipients and a control group were surveyed before and after the e-bike subvention programme; more precisely, a non-equivalent-groups design (Cook & Campbell, 1979).

Our case illustrates that a shift in transport mode distribution resulting from a bicycle measure will involve transfer not only from private car but also from public transport and walking. The overall benefits due to health gains will shrink if a considerable share of the new bicycling originates from walking rather than motorised transport; and the benefit of reduced negative external effects from motorised transport will shrink if a large share of it originates from public transport.

Another issue relates to what the economic health effects should include in a CBA, and in a similar vein, whether part of the negative external from motorised transport are already paid for via taxes (Börjesson & Eliasson, 2012). In our main analysis, we include only external health effects (physical activity as well as injury), the impacts on others, not the internal effects (the individuals' own gains and losses from their own transport/activity choices). Moreover, we take existing distance-based (fuel-based) taxes into account in our CBA. To our knowledge, no former CBA study of bicycling measures has assessed that a share of the negative external effects is internalised via taxes.

The remainder of the paper is structured as follows: The next section provides an overview of CBA analyses of measures to promote cycling. The third section present the methodological approaches, data, and modelling assumptions. The results of the CBA, including sensitivity analyses, are displayed in the fourth section. The fifth section discusses our findings, that are concluded in the last section.

2. Literature survey – CBA of active transport measures

Sælensminde (2004) presented a CBA of cycle/walk infrastructure construction in three Norwegian cities, introducing benefits from reduced illness risk due to increased physical activity. He assumed that 15% of car trips shorter than 5 km would be shifted to cycling and walking in a ratio of 2 to 1, following from completing the main cycle/walk networks (the remaining shares varied considerably between the three cities, from about 6% to about 36%). 50% of additional kilometres cycled/walked were assumed to yield net health benefits, measured as reduced external costs of treatment of specific chronic diseases as well as absenteeism. He added individuals' own valuation of illness risk reduction, handling this element as an external effect. The reduction in car trips yielded reductions in negative external effects from emissions and congestion. The estimated health benefits dominated the other benefit elements and total benefits were 2–10 times larger than the infrastructure costs.

Götschi (2011) presents a CBA of bicycling infrastructure investment in Portland. The point of departure was an observed increase in cycling in counts from 1991 to 2008. The City of Portland had launched plans and cost estimates for bikeway network rebuilding. Applying projected bicycle mode shares and distance cycled for three different plans, with different cost levels, Götschi calculated health care cost savings, following from reduced physical inactivity, based on estimates from Colditz (1999) and Wang et al., (2004a), as well as fuel cost changes due to transport mode shifts. Götschi (2011) also estimated individuals' expected health benefits applying the WHO-based health economic assessment tool, which was based on mortality as health endpoint and valuation of a statistical life as monetary measure (see Kahlmeier et al., 2017, for an updated and extended version). The estimated benefit-cost ratios thus depended heavily on the inclusion or not of the individual health benefits, varying from just above 1 to nearly 4 when omitted to an interval of 20–50 when included.

Beale et al. (2012) present a CBA of cycle/walk infrastructure investment in England. Regarding the impact of new trails on use (cycling), they applied figures from different studies and areas, ranging from 10 to 50 percent increase (Mamoli, 2003; 2004; Cope et al., 2003), with slightly more than 20% of these being new users (Gordon et al., 2004). The average cycle trip was set to 3.9km, and new users were assumed to cycle about one trip per week on the new trail. Beale et al. (2012) included third party health benefits, reduced short-term absenteeism and long-term illness; and they included all individual gains for the active transport users themselves. The valuations underlying the benefit estimates are not fully clear, but they state that health benefits comprise about 66% of total benefits and, in addition, 23% was due to reduced absenteeism. They applied trail cost figures from Wang et al., (2004b). Total estimated benefits, of 2.60 GBP per user per km (2006-GBP), were more than tenfold the estimated trail cost per user per km, 0.22 GBP.

Rabl and de Nazelle (2012) presented an economic benefit assessment of a hypothetical car driver who switched "to bicycling for a commute of 5km (one way) 5days/week 46weeks/yr" (p. 121). They also assessed a similar shift to walking. The positive exercise effect was found to dominate the net health effect relative to air pollution exposure and accidents, although the net effect will depend on the site and context for the shift in transport mode (see also de Hartog et al., 2010, and Rojas-Rueda et al., 2016). Rabl and de Nazelle (2012) applied mortality as endpoint in their health benefit calculus, based on dose–response estimates from the WHO, and the monetary measure was the valuation of prevented fatalities. In addition to the individual health effect for the person switching mode, they also included the external effects in terms of reduced emissions from motorised transport and reduced congestion (applying proposed valuations for European countries from Bickel and Friedrich, 2001, Bickel and Friedrich, 2005). The individuals' estimated health benefits of the mode switch were more than an order of magnitude larger than the benefits to the society.

Gössling and Choi (2015) compared costs of cycling and car driving in Copenhagen. They included individuals' user costs (the value of travel time savings plus vehicle operating costs) as well as external negative and positive benefits (congestion, noise, air pollution, global warming, accidents; and, positive benefits from cycling: health, prolonged life, and branding/tourism). The unit values were those applied by the Danish Ministry of Transport. Gössling and Choi (2015) summed the costs and negative benefits per vehicle km, while positive benefits were subtracted (p.111): "When all aspects are included, the cost of a km cycled is Euro 0.08, while a km driven by car is Euro 0.50. Considering only social costs, each bicycle km is a gain to society (Euro 0.16), while each car km represents a cost (Euro 0.15).".

The above-mentioned CBA studies all relate to infrastructure measures. We have not found CBA studies involving financial incentives for e-bikes or ordinary bicycles (see also Cleland et al., 2023). There exist however studies that assess the impacts on cycling from financial impacts. Martin et al. (2012) provided a review, summarising significant shifts to cycling from a "free bicycle", in, e.g., Bunde et al., (1997, see also Surborg et al., 2001) and Bauman et al. (2008). Martin et al. (2012) only refer to studies that applied hypothetical monetary payments for cycling (e.g., Wardman et al., 2007); but, e.g., Ciccone et al. (2021) compared actual payments and lotteries, finding that the latter could provide the same impact for a lower implementation cost. De Groote et al. (2019) found that payment for commuting by bicycle during the winter season, in the Netherlands (0.5-1€ per day, depending on travel distance) had a relatively weak demand-reducing effect on car parking. Sundfør and Fyhri (2017) found positive effects on physical activity levels from a smaller-scale e-bike subvention scheme run by an NGO, in Oslo and Tromsø; the subsidy structure was similar to the one applied by Oslo City Government in 2016, but the NGO applied stricter qualification rules.[2]

3. Assumptions and input data

3.1. Approach to the cost-benefit analysis

What drives the results of the CBA of the above-referred studies is the inclusion of the cyclists' (mode switchers') own health benefit gain, the health effect that they control themselves and that affects themselves. From one perspective, including this benefit element seems the right thing to do; the public measure brings about a shift in transport mode choice that affects individuals' transport behaviour and physical activity, and all effects ought to be included in the CBA. However, from another perspective, to the extent that individuals are well informed, they have already assessed at the outset the health effects from active transport against other effects (Sturm, 2004). They draw on these internal health effects trough, e.g., the lowering of the perceived discomfort when cycling or walking. Their internal health gains can be manifested in their (lowered) valuation of time savings (Börjesson and Eliasson, 2012, Flügel et al., 2021). Börjesson and Eliasson (2012) argue that inclusion of individuals' own health benefits from physical activity might lead to "double-counting":

"If, hypothetically, travelers do consider the health effects they will get from cycling and make an accurate judgment of them, then the health benefits will turn up as part of the consumer surplus – both as increased demand for cycling and as a lower value of cycling time – compared to a situation where travelers do not consider health effects. Adding health benefits to a CBA if cyclists already factor in the health effects they are getting will hence be double-counting" (Börjesson and Eliasson, 2012, p. 680)

Flügel et al. (2021) present a test of the health gain effect on the valuation of travel time savings, that indicate that travellers at least partially take the health impact into account when choosing to cycle for transport (see also Götschi & Hintermann, 2014). The health gain from a policy measure that produces an increase in cycling also depends on the physical activity levels before switching to (or increasing) cycling, whether the new (more active) cyclists are relatively inactive at the outset or not (Veisten et al., 2011).

In the official CBA handbook for road transport projects in Norway (NPRA, 2021), third party cost reductions resulting from increased physical activity are still based on the two components from Sælensminde (2004): i) the expected short term reduction in job absenteeism and ii) the expected long term reduction in chronic illness. Individuals' own (internal) health gains are added as external benefits; and these are estimated with respect to an expected increase in quality-adjusted life years (Sælensminde & Bryde-Erichsen, 2017). Based on the unit values and assumptions about annual travel lengths (8 km cycled / 4 km walked, 5 days per week), as well as an assumption about the net increase in physical activity from increased cycling/walking), an economic value per km can be derived (Sælensminde and Bryde-Erichsen, 2017, Npra, 2018). In the newest official CBA handbook, the share of new cyclist obtaining net positive health effect is reduced from 50% to 30% and for new pedestrians it is reduced from 50% to 15% (NPRA, 2021, p. 71-72); an adjustment that follows estimates from Veisten et al. (2011). Our main assumption in this study will be based on applying only third-party health care gains, assuming that individuals are factoring in completely their own health gains. We will, however, present sensitivity analyses that include these individual health gains in the benefit estimates (following NPRA, 2021). Thus, we compare CBA results from both omitting and including individual health gains, similarly to Götschi (2011).

Another pertinent question is to which extent health effects formerly estimated for ordinary bicycle travel can be applied in the case of e-bike (pedelec) projects. The physical intensity level for travel by e-bikes is lower than for conventional bicycles (Berntsen et al., 2017); seemingly closer to pedestrians' intensity level (Gojanovic et al., 2011). For walking, in the official Norwegian valuation approach, there is seemingly an underlying assumption of similar physical intensity level in cycling and walking (Sælensminde & Bryde-Erichsen, 2017); thus walking obtains considerably higher valuation per km than (regular) cycling due to the lower speed. Castro et al. (2019) analyse health effects from e-bikes and assert "that e-bikers may compensate, at least in part, the lower effort per kilometre of e-biking by traveling longer distances" (p. 6). If a health-effect valuation per distance travelled (per km) is applied, it seems correct to set that value lower for e-biking than for regular bicycling. Specific health effect values for e-bikes do not exist in the Norwegian official handbook, but we will test the impact of setting lower valuation per km for e-bikes relative to ordinary bicycles in our analysis (see also McVicar et al., 2022).

Rabl and de Nazelle (2012) considered the negative health effects from active transport due to air pollution and injury risk. Injury risk is relatively high for cycling in Norway (Bjørnskau, 2018); even more so when single-bicycle accidents are included (Veisten et al., 2007, Bjørnskau, 2018, Kasnatscheew et al., 2018). Studies on the injury risk for e-bikes (pedelecs) are limited, but the increased weight and speed predict increased injury severity (Elvik, 2013), as indeed found by Poos et al. (2017). However, the empirical foundation is still scarce and not unambiguous (Fyhri et al., 2019). Thus, we apply similar reduction of health values due to injury risk for e-biking as for regular cycling, as our default. But we will test for an injury risk difference, and subsequent difference in overall positive plus negative health values for e-bike users, in a sensitivity analysis. Regarding possible negative health effects on active transport due to air pollution (de Hartog et al., 2010), we disregard such effects in our Oslo case.

Two of the referred CBA studies, Rabl and de Nazelle (2012) and Gössling and Choi (2015), assessed the effect of a reduction in four-wheel motorised transport when individuals switch to more active transport. We proceed in a similar way, calculating changes in marginal external costs from transport due to shifts in transport mode distribution. The monetary values for various negative external effects from, primarily, cars and other motor vehicles, are primarily based on Rødseth et al. (2019). We have added a revised estimate of the marginal external costs of injuries/fatalities. Instead of public police-registered accident data, that are prone to under-reporting, we apply recent under-reporting estimates from Lund (2019) to re-estimate the figures from Rødseth et al. (2019). We add the active transport health gain as a "negative marginal illness cost"; that is, the marginal health benefit, from cycling and walking. As indicated above, we include only the purely external costs from the official manual (NPRA, 2021). When we in sensitivity analysis add internal health gains, we also add the internal injury costs, for consistency in the overall health effect estimate.

Börjesson and Eliasson (2012, p. 681) argue that "only the non-internalized part of external costs from traffic should be included in a CBA". Existing taxes directly related to the "production" of external effects, like road pricing, tolls, and fuel taxes, will bring about internalisation, such that the road users perceive these costs themselves (Newbery, 1990, Newbery, 1992). Taxing will then already have affected motorized transport downwards, most probably bringing the level of transport closer to the economically optimal level. Santos (2017) found that the internalisation rate was lower for vehicles running in diesel compared to petrol, in European countries. The same was found by Rødseth et al. (2019), but in both cases the internalisation rate was quite low; it was estimated to 12% for diesel and 17% for petrol (Table 1). The type of taxing they considered was the fuel-based CO_2 tax and road use tax. These fuel taxes are also paid by operators of trains run by diesel locomotives. There exist also track access charges for rail-based transport, but for passenger train operators these taxes are covered by the public purchase of transport services (NRD, 2023, p. 10).

Table 1. Marginal external costs from transport in Norwegian cities – EUR_{2020} per vehicle kilometre.

Effect	**Car, petrol**	**Car, diesel**	**Car, hybrid**	**Car, el.**	**Bus, diesel**	**Bus, CNG**	**Tram**	**Metro**	**Train**	**Cycle**	**Walk**
Congestion, peak hours	0.3448	0.3448	0.3448	0.3448	0.3448	0.3448	0	0	0	0	0
Congestion, off-peak	0.0294	0.0294	0.0294	0.0294	0.0294	0.0294	0	0	0	0	0
CO_2, peak hours	0.0161	0.0142	0.0081	0	0.0831	0.1011	0	0	0	0	0
CO_2, off-peak	0.003	0.0025	0.0015	0	0.0192	0.0226	0	0	0	0	0
PM_{10}, NO_X, peak hours	0.0576	0.1011	0.0576	0.0227	0.6102	0.5526	0	0	0	0	0
PM_{10}, NO_X, off-peak	0.0126	0.0226	0.0126	0.0227	0.1379	0.1253	0	0	0	0	0
Noise	0.0312	0.0312	0.0312	0.0312	0.2257	0.2257	0.1133	0.0567	0.1133	0	0
Wear and tear (adj. based on Bertelsen et al., 2021)	0.0046	0.0046	0.0046	0.0046	0.0057	0.0057	1.5462	1.5462	3.0925	0	0
Management	0	0	0	0	0	0	0.8539	0.8539	1.7078	0	0
Injuries/ fatalities (adj. based on Lund, 2019)	0.0198	0.0198	0.0198	0.0198	0.0425	0.0425	0.7594	0.1190	0.1048	0.1322	0.0973
Illness										−0.25	−0.68
Sum, peak hours	0.4741	0.5157	0.4661	0.4231	1.3120	1.2724	3.2728	2.5758	5.0184	−0.1178	−0.5827
Sum, off-peak	0.1006	0.1101	0.0991	0.1077	0.4604	0.4512					
Internalisation rate	17%	12%	*8.5%*	0%	30%	7%	*0%*	*0%*	*0%*	*0%*	*0%*

Sources: Rødseth et al., (2019, Tables 2, 3, 4, 104, 105, V3.2, V3.3); the injury/fatality costs are updated using estimates of underreporting from Lund (2019); and the wear and tear cost for cars adjusted by a factor of 1.62, while the cost for buses is an average of light and heavy trucks, based on Bertelsen et al., (2021,p. 13). We derive figures for metro and tram based on marginal cost estimates for trains (Rødseth et al., 2019), somewhat cursory halving the cost of wear and tear management, and, for metro, halving the noise cost. The internalisation rates for cars and buses are due to Rødseth et al. (2019). The original marginal cost estimates in Norwegian kroner (NOK) are CPI-updated from NOK_{2019} to NOK_{2020} by 1.0126 and then multiplied by 1/10.72, which was the average EUR/NOK exchange rate in 2020. The original valuations of marginal illness reduction (positive health gain), from NPRA (2021), were given in NOK_{2020}, thus multiplied directly by 1/10.72 to obtain EUR_{2020}. (CNG refers to compressed natural gas, CO_2 to carbon dioxide, PM_{10}, to particulate matter with diameters less than or equal to 10 µm, and NO_X refers to nitrogen oxides.).

The marginal cost estimates in Table 1 will be downscaled for the transport modes that have an estimated internalisation rate above 0. Thus, e.g., for petrol cars, the marginal costs in our analysis will be 83% of those presented in the table. All marginal cost elements will be downscaled by the same percentage, not taking account of the probable variation in the internalisation rate across the external effects.

The alternative valuation of health effects when including internal effects (based on NPRA, 2021) will be about €1.37 and €2.17 per km, respectively for cycling and for walking, instead of €0.25 and €0.68. But then, when we apply the higher health gain estimates including internal effect, we also include internal injury costs, for consistency; the injury costs will then be €2.14 and €2.84 (based on Kasnatscheew et al., 2018) instead of €0.1322 and €0.0973, respectively for cycle and walk. Actually, that yields negative health benefits for cycling and walking, as the absolute value of the injury risk cost is higher than that of the illness risk-reduction cost.

In the alternative assumptions about the e-bike travelling, we apply 25% lower health gains compared to ordinary cycling (€0.19 as external gains instead of €0.25, and €0.75 in external plus internal instead of €1.37); and we assume alternatively 25% higher injury costs (€0.1653 as external costs instead of €0.1322, and €2.68 in external plus internal instead of €2.14).

Our data do not allow for estimation of travellers' consumer surplus changes (e.g., Standen et al., 2019), since we have little information about the travel alternatives that the participants face.

3.2. The empirical evidence on mode shift

The new-elected Oslo City Government, in late 2015, had set a policy target of increasing the bicycle share in Oslo (Lunke & Grue, 2018). Back then, the e-bike usage had reached levels that indicated additional or different impacts compared to ordinary bicycles, e.g., increased gender and age balance, as well as reducing topography barriers (Fyhri and Fearnley, 2015, Fyhri et al., 2017). The Oslo City Government announced that, in January 2016, there would be launched an e-bike subvention webpage; the first 1000 applicants would be awarded a 20% subsidy on their e-bike purchase, the maximum subvention set to 5000 NOK (≈500 EUR). The only eligibility for subvention qualification was home address in Oslo and age of majority (≥18); and then, first come, first served. All 1000 subvention qualifications were reserved already during the first labour days of January 2016 (Dagsavisen, 2016).

In parallel to the subvention programme, surveys about e-bike purchase and transport mode usage were initiated, targeting those applying for subvention, but also adding an additional register of bicycle insurance buyers living in Oslo (Fyhri et al., 2016, Sundfør and Fyhri, 2022). Individuals from the bicycle insurance register were sampled for a pre-survey (t_0), a baseline survey, in early 2016. All subvention applicants/receivers were required to complete the baseline survey before using their new e-bike. A post-survey (t_1) was then carried out among the individuals from both groups (subvention qualifiers and bicycle-insurance buyers) that had participated in the pre-survey. The before-after design enabled comparison of changes in transport mode usage in the subvention-qualifier group I relative to the changes in the group of insurance buyers I. Furthermore, some among the 1000 having qualified for e-bike purchase ended up not buying an e-bike; and they can be applied as a secondary control group (CR), in addition to the control group from the bicycle insurance register.

Sundfør and Fyhri (2022) present estimates of the relative change in transport mode distribution for the beneficiaries of the Oslo e-bike subvention programme, R, compared to the two control groups, C and CR (Table 2).

Table 2. Transport mode shares and daily travel distance – before (t_0) and after (t_1) the e-bike subvention programme.

	Recipient group (R)		Control groups				Relative change in the mean daily travel distances, km	
			Insurance-register sample (C)		Qualifying for subvention but not buying e-bike (CR)		R vs. C	R vs. CR
	t_0	t_1	t_0	t_1	t_0	t_1	$t_0 \rightarrow t_1$	$t_0 \rightarrow t_1$
Cycle	10.4%	48.8%	19.9%	34.8%	10.8%	16.9%	3.7	5.5
Walk	12.2%	6.9%	13.2%	11.9%	11.0%	10.4%	−0.6	−0.6
Public transport	28.0%	9.5%	30.2%	21.8%	24.1%	27.4%	−1.4	−3.3
Private car	49.4%	34.8%	36.7%	31.6%	54.1%	45.4%	−1.3	−0.5
All modes	100%	100%	100%	100%	100%	100%	0.4	1.1
Total travel distance (km)	15.9	16.5	17.7	17.9	16.6	16.1		
E-bike share of all cycling	21%	68%	11%	14%	3%	8%		
N	382		662		215			

Source: Sundfør and Fyhri (2022), with own adjustments.

The estimation method applied by Sundfør and Fyhri (2022) was equivalent to the difference-in-differences (DID) method.[3] The mode shift estimations (respectively for bicycle, regular and e-bike, walk, public transport, and private car) were based on a non-equivalent-groups design; a before-after study with control group, with a non-random assignment to treatment and control groups (Cook & Campbell, 1979). More precisely, Sundfør and Fyhri (2022) present two types of intervention-control comparisons: i) the intervention group of e-bike subvention beneficiaries (R) versus a comparison group sampled from a bicycle insurance register (C); and ii) the intervention group (R) versus those having qualified for but not applied their e-bike subvention (CR).

The e-bike share of daily cycle kilometres at the outset (t_0) was considerably higher in the recipient group than in the control groups. There is a slight increase in the e-bike share in all control groups, from t_0 to t_1, possibly reflecting a seasonal change and the underlying increase in e-bike use; while in the recipient group the e-bike share of cycling kilometres increases to 70%. The relative increase in (all) cycling in the recipient group versus control groups is statistically significant, which is also the case for the relative decrease in public transport. It is however clear that there is also a seasonal effect, from t_0 to t_1; that only t_1 is fully within the cycling season in Oslo (Sundfør & Fyhri, 2022).

3.3. The cost of implementing the e-bike subvention programme

We have obtained estimated costs of the e-bike subvention programme from the representatives of the municipality of Oslo (Table 3). These are the aggregated costs for the years 2016 and 2017. The costs cover the municipalities own planning, the consultancy services they bought from a firm that administrated the list of qualified individuals for subvention and the transfers of the e-bike purchase subsidies, as well as a money transfer amount.

Table 3. Implementation costs and transfers for e-bike purchases (EUR_{2020}).

Implementation costs and transfers for e-bike purchases	Consultancy firm		City Government	Total, administration	Assumed variable	Assumed fixed
	Transfers	**Administration**	**Administration**			
2016	65,000	9700	*25,300*	*35,000*	*5000*	*30,000*
2017	16,400	6500	*0*	*6500*	*1000*	*5500*
Total	81,400	16,200	25,300	41,500	*6000*	*35,500*

Source: City of Oslo, Morten Haugen (pers. comm.). The original implementation cost estimates in NOK_{2016} are wage-index updated to NOK_{2020} (1.083012) and then multiplied by 1/10.72, the average EUR/NOK exchange rate in 2020. The EUR estimates are rounded to the nearest hundred.

We lack information about how the administrative costs (labour costs) can be divided between fixed costs (e.g., planning, budgeting, reporting) and costs that vary with respect to the number of subvention applicants/recipients. For the analysis of the specified subvention programme, such a differentiation of fixed versus variable costs will not affect net benefit estimates. However, the differentiation will have some impact in an economic assessment of variations in the number of allowed subvention recipients.

We have assumed an average labour cost of 50 Euro per hour (Eurostat, 2022). Part of the consultancy firm's administrative labour was most likely applied to the following-up of recipients and the subsidy transfers for e-bike purchases. Implicitly we retain some 3–4 weeks as fixed preparation costs for the consultancy, in 2016, and 1–2 weeks in 2017 for reporting; the rest assumed to be variable follow-up costs for the e-bike subsidy recipients. That will imply about 5 min, i.e., ca. 4.2 Euro in variable cost, per subvention recipient; we assume that some administration was necessary for all 1000 individuals qualifying for subvention. Thus, the variable part is assumed to be ca. €4.2×1000=€4200. The fixed part, the 710 planning/preparation and reporting hours amounts to €50×710=€35,500.

Probably the web-based first-come first served basis for obtaining subsidised e-bike purchase is among the least costly ways that such subventions can be carried-out. It implies some planning and administration, but the fixed costs as well as the variable costs per recipient are relatively low. There was, e.g., no health-related screening of the applicants, that has been applied in similar programmes (Sundfør & Fyhri, 2017), which would increase considerably the cost per recipient.

The subvention transferred for the e-bike purchases are not part of the implementation costs. These are transfers of resources from one entity, the municipality, to another entity, the e-bike purchaser. That is, the money was transferred via the consultancy firm to the e-bike retailer, covering the difference between the ordinary price and the subsidised price.[4]

3.4. Detailed assumptions concerning mode shifts

It was expected at the outset that the e-bike subvention programme would bring about transport mode shifts in the recipient group, as already found by Sundfør & Fyhri et al. (2021). It is the transport mode changes that will drive the changes in external effects and, subsequently, the economic benefits of the programme.

The changes in external effects from transport mode change will depend on the pattern of change as well as many other characteristics of the transport modes and traffic conditions. Table 4 lists our assumptions regarding the net health impact of (increased) active transport, transport mode distributions, road traffic conditions, and the subvention programme, with alternative assumptions (in parentheses) that are tested in sensitivity analyses.

Table 4. Assumptions regarding active transport health effects, transport mode features, traffic conditions, and the subvention programme (with alternative assumptions shown in parentheses).

Valuation of net health effects (well-being/illness risk and injury risk) from active transport			
E-bike, pedelec (EUR_{2020}/km)	€0.12 (€0.02 / -€0.77)		
Ordinary bicycle (EUR_{2020}/km)	€0.12 (€0.12 / -€0.77)		
Walk (EUR_{2020}/km)	€0.59 (€0.59 / -€0.67)		
Transport modes / technologies	Share (private car and public transport)	Occupancy, rush hours	Occupancy, non-rush
Car, petrol	42% (30%)	1.1	1.3
Car, diesel	38% (30%)	1.1	1.3
Car, hybrid	12% (20%	1.1	1.3
Car, electric	8% (20%)	1.1	1.3
Private car	100% (100%)		
Bus, diesel	17.5%	35 (30)	15 (10)
Bus, CNG	17.5%	35 (30)	15 (10)

Valuation of net health effects (well-being/illness risk and injury risk) from active transport			
Train (sub-urban / commuter)	11%	170 (150)	100 (75)
Tram	18%	120 (60)	60 (40)
Metro	36%	300 (250)	160 (120)
Public transport	100%		
Road traffic conditions			
Share rush hour	35% (25%)		
Share non-rush	65% (75%)		
The execution of the e-bike subvention programme (NOK-2016)			
Hours per applicant (→variable costs)	0.083333 (0.166667)		
Fixed amount of hours (→fixed costs)	710		
Cost of labour (EUR_{2020}/h)	€50		
Completion rate (recipients)	70% (50%)		
Bicycle season length (days)	200 (150)		

Regarding the marginal cost estimates for cars and public transport per vehicle km (Table 1), firstly the share already internalised via taxes per km is subtracted, and then the cost per person km is derived dividing by the occupancy. We have no information about the individuals' car marks and types nor the type of public transport they apply; and we also lack other information about their travel patterns. Hence, we apply the average distributions of car fuel technologies and public transport usage in Oslo, in 2016. The alternative assumptions, in parentheses, reflect to a large extent the development after 2016, the increase in the share of electric cars and the recent COVID-19 impact on public transport (Table 4).

Finally, close to 700 of those qualifying for the e-bike subvention bought an e-bike, yielding an approximate completion rate of 70% of the 1000 qualifying. A lower completion rate (50% as an alternative) yields lower impacts and slightly higher implicit average implementation costs per e-bike subvention user. Another variable affecting annual impacts is the average length of the bicycle season for those receiving an e-bike subvention. While some cycle even in winter, most cycle primarily in the months from April to October. We apply 200 as main assumption of average annual cycle days, following Fyhri et al. (2016); but we test the effect of a shorter average (150).[5]

For e-bike net health impacts we include two alternative assumptions; one sets a slightly lower expected health gain per km (75%) compared to ordinary bicycling combined with slightly higher injury risk cost (125%); the other alternative assumption is common for all active transport modes, adding the internal expected health gains and internal injury risk costs (Table 4).

4. Results

Table 5 shows the estimated changes in the marginal effects, in EUR_{2020}, following from the average mode shifts presented in Table 2 and our valuations (marginal costs) and assumptions (Table 1, Table 4). The monetised difference-in-difference estimates for the e-bike subvention recipients (R) are shown for both control groups, the sub-sample from the bicycle insurance register (C) and the sub-sample having qualified for subvention but not having bought an e-bike (CR).

Table 5. Estimated marginal external effects of the average transport mode distribution, EUR_{2020} per person kilometre, before (t_0) and after (t_1) the e-bike subvention programme.

	Recipient group (R)		**Control groups**				**Relative change in the marginal effect, EUR_{2020}**	
			Insurance register sample (C)		**Qualifying for subvention but not buying e-bike (CR)**		**R vs. C**	**R vs. CR**
	t_0	t_1	t_0	t_1	t_0	t_1	$t_0 \rightarrow t_1$	$t_0 \rightarrow t_1$
Motorised travel								
CO_2	−0.002	−0.002	−0.002	−0.002	−0.003	−0.002	0.000	0.000
PM_{10}, NO_X	−0.014	−0.010	−0.011	−0.009	−0.016	−0.013	0.003	0.002
Road noise	−0.012	−0.008	−0.009	−0.008	−0.013	−0.011	0.003	0.002
Wear and tear	−0.004	−0.002	−0.004	−0.003	−0.004	−0.004	0.001	0.002
Management	−0.001	−0.001	−0.002	−0.001	−0.001	−0.001	0.001	0.001
Congestion	−0.054	−0.039	−0.040	−0.035	−0.059	−0.050	0.010	0.007
Accidents	−0.008	−0.005	−0.006	−0.005	−0.008	−0.007	0.002	0.001
Active travel (health)	0.084	0.099	0.102	0.112	0.078	0.081	0.005	0.012
Sum	−0.012	0.031	0.027	0.049	−0.026	−0.008	0.024	0.028
Annual benefits							56,457	64,792

The health effect for active travel is a sum of expected health gains due to physical activity and the injury risk change. The annual benefits are derived by multiplying the sum of marginal effects per km by the t_1 daily distance (for the treatment group, R, 16.5 km), the annual cycle days (200), and the estimated final number of recipients (700).[6]

Table 6a, Table 6b list the annual benefit-cost estimates, respectively for R vs. C and R vs. CR. The leftmost column shows the estimated annual benefits from individual observations ("DID monetised"). This is a regression of the benefit change from t_0 to t_1 in the recipient group (R) versus the control groups (C or CR), aggregating to annual estimates using 200 days as fixed cycle season length.[7] The 95% confidence interval is thus derived from the distribution of individual observations. The lower bound benefit estimate drops below the implementation cost in the R vs. C comparison, but not for the R vs. CR comparison.

Table 6a. Cost-benefit analysis of the e-bike subvention programme including sensitivity analyses, EUR_{2020} per year, R vs. C.

	Main assumptions		**Higher share of electric cars**	**Lower share of conges-tion**	**Lower occupation in public transport**	**Lower health benefits for e-bike travel**	**Shorter bicycle season**	**Internal values in valuation of health impacts**	**Higher variable costs**
	DID mone-tised	**Monetised results of annual averages from DID, average transport mode shares before and after**							
Lower 95% CI	34,737								
Annual benefits	50,093	56,457	56,819	49,758	58,719	−10,703	42,343	−310,387	56,457
Upper 95% CI	65,448								
Annual costs of implementation	−39,667								−43,833
Lower 95% CI	−4,930								
Net benefits	10,426	16,790	17,152	10,092	19,052	−50,370	2,676	−350,054	12,624
Upper 95% CI	25,782								
Lower 95% CI	0.9								
Benefit-cost ratio	1.3	1.4	1.4	1.3	1.5		1.1		1.3
Upper 95% CI	1.6								

Table 6b. Cost-benefit analysis of the e-bike subvention programme including sensitivity analyses, EUR_{2020} per year, R vs. CR.

	Main assumptions	**Higher share of electric cars**	**Lower share of conges-tion**	**Lower occupation in public transport**	**Lower health benefits for e-bike travel**	**Shorter bicycle season**	**Internal values in valuation of health impacts**	**Higher variable costs**
	DID mone-tised	**Monetised results of annual averages from DID, average transport mode shares before and after**						
Lower 95% CI	43,202							

	Main assumptions	Higher share of electric cars		Lower share of conges-tion	Lower occupation in public transport	Lower health benefits for e-bike travel	Shorter bicycle season	Internal values in valuation of health impacts	Higher variable costs
	DID mone-tised	Monetised results of annual averages from DID, average transport mode shares before and after							
Annual benefits	63,023	64,792	65,017	60,906	69,712	−6,049	48,594	−465,152	64,792
Upper 95% CI	82,844								
Annual costs of implementation	−39,667								−43,833
Lower 95% CI	3,535								
Net benefits	23,356	25,125	25,351	21,240	30,046	−45,716	8,927	−504,818	20,958
Upper 95% CI	43,177								
Lower 95% CI	1.1								
Benefit-cost ratio	1.6	1.6	1.6	1.5	1.8		1.2		1.5
Upper 95% CI	2.1								

We have added benefit estimates applying the difference-in-difference model to the average transport mode usage in t_0 to t_1 (Table 2). These are shown in the second left-hand result columns of Table 6a and Table 6b; these are consistent with the results shown in Table 5. The annual benefit estimate using average values come close to that based on individual values. Table 6a, Table 6b also show the e-bike programme implementation costs, and the subsequent net benefit estimates and estimated benefit-cost ratios. The point estimates of the benefit-cost ratios are around 1.5, slightly above for the R-CR comparison and slightly below for the R-C comparison.

Table 6a, Table 6b include the estimates from the sensitivity analyses. These sensitivity analyses were based on the estimation using average values for the transport mode usage, not the original individual data. Only two of the alternative assumptions alter completely the results. The inclusion of internal impacts in the health effects from active travel results in negative net health values from increased active travel, because the internal injury risk cost outweighs the internal health gain benefit. Both cycling and walking has relatively high internal injury risk (due to a high share of single accidents and a high relative share of injury in collisions with other transport modes), but walking has higher internal health gain benefit (driven by the lower speed, thus yielding higher km-based values).

A lower health gain and higher injury risk cost for e-bike travel will also render overall benefit estimates negative. A shorter bicycle season (from 200 to 150days) will also reduce the active travel benefits. Alterations in the assumptions regarding fuel technologies (higher share of electric cars), occupancy in public transport, and congestion levels, will have relatively limited impact on the annual benefits and net benefits. Spending twice as much time on each qualified subvention recipient will also have limited impact on the implementation costs and the net benefits, for our given input; but that (variable cost) effect will increase relatively if increasing the allowable no. of recipients above 1000.

5. Discussion

We have shown a cost-benefit analysis of a simplistic policy measure aiming for increased active travel, a municipal e-bike subvention programme in Oslo, Norway. Grant applicants, limited to 1000 persons, could obtain a subsidy when purchasing a new e-bike, a pedelec, up to 20% of the ordinary price, maximum 5000 NOK (about €500). We have monetised the transport mode shifts estimated by difference-in-difference methodology, a before-after study with non-random assignment to treatment and control groups (Sundfør & Fyhri, 2022). The sample of the subvention recipients who purchased an e-bike (n_R=382) was compared against a control group drawn from a bicycle insurance register (n_C=662) as well as against another control group of those qualifying for subvention but had not bought an e-bike (n_{CR}=215). Notwithstanding the control group, the difference-in-difference showed that the e-bike subvention programme yielded a shift from car driving, public transport, and walking towards cycling, particularly by e-bike. The similar result for both control groups indicates that the seasonality shift, from the survey before to the survey after, have not distorted the control.

The monetised changes in health impacts from the relative increase in cycling and the monetised change in external costs due to reduction in car-driving and public transport yielded a mode shift benefit. Estimated annual benefits were higher than the estimated costs of implementing the e-bike subvention programme. The simple first-come first-served qualification (via a municipal website, in January 2016) yielded relatively low administration costs for the policy measure.

The CBA result estimates follow from an implicit assumption of only one-year effect of the e-bike subvention programme. Although the effect decays over time, an effect duration of only bicycle season seems clearly too pessimistic. If some effect on the transport mode distribution is pursued in the following seasons, that would add to the net benefits, if the shift to e-bike has higher positive than negative benefits, because the effects in the second and following years would come at no additional implementation costs. However, we lack the data for quantifying these additional net benefits.

Self-selection to the subsidy recipient group could imply that the actual health gains are lower than implicitly assumed, e.g., if the e-bike subvention primarily advanced already planned purchases. Those applying for e-bike subsidising could also be relatively more motivated towards cycling. The latter might also have a bearing upon the assumed effect of extending/generalising the subvention programme. Self-selection problems can then be reduced, or vanish, but eventually the interest in applying for subsidised e-bikes might decrease. De Groote et al. (2019) reflect on effect differences from financial incentives between cities/countries with different transport mode distributions. Supposedly, the impact on transport mode choice from financial bicycle promotion measures is potentially higher in areas with lower cycling levels at the outset.

The result of our CBA is primarily affected by the approach to the valuation of health effects from active travel. Our main assumption was based on including only external health effects, following, e.g., van Wee and Börjesson (2015) and Börjesson & Eliasson (2012). This implicitly assumes that individuals are informed about health risks, the impact on risk of injury and the impact on illness risk when cycling/walking for transport (Sælensminde, 2004). As we apply active travel injury risk estimates that include non-reported single accidents (Bjørnsaku, 2018; Kasnatscheew et al., 2018, Lund, 2019), the resulting valuation of internal injury risk increase will outweigh the valuation of internal illness risk reduction; and the sum of external and internal injury risk valuation per km will outweigh the sum of external and internal illness risk valuation per km, based on official unit values (NPRA, 2021).[8] Thus, including the valuation of internal impacts in the CBA will yield negative benefits. The reason why our comparison of including and excluding internal impacts yield different results from, e.g., Götschi (2011) and Beale et al. (2012), is primarily that we include the injury risk increase when shifting to active travel. The internal part is considerably larger than the external, for injury risk as well as the illness risk and fitness effect (Sælensminde, 2004, Beale et al., 2012, Rødseth et al., 2019). When including only external effects, there will be some system externality due to cycling (or walking), the costs for the health sector, etc. But the physical injury externality, the injury impact on other road users, is very limited compared to physical injury externality produced by larger vehicles (Elvik, 1994, Rødseth et al., 2019). The system externality effect from reduced illness risk and reduced absenteeism, for cycling (and walking) is relatively more important, based on official Norwegian valuations (NPRA, 2021).

In our main assumptions for the CBA, e-biking was treated as ordinary bicycling in terms of health gains and injury risk per km. In sensitivity analyses, we tested the effect of reducing the e-bike health gain to 75% of that from ordinary bicycling, per km, and concurrently increasing the injury risk to 125%. These adjustments yielded negative net benefits. Thus, the relative health impact from e-biking compared to ordinary bicycling, in terms of both fitness/illness and injury risk, is an important parametre for policies that primarily target increasing e-bike transport. It remains important even if e-bikes attracts other populations segments than ordinary bicycles or that e-bike users travel longer distances (Cairns et al., 2017, Castro et al., 2019, McVicar et al., 2022). What matters more, however, is whether e-biking substitutes for walking / ordinary bicycling or travel by car, as well as the activity level of those who shift to e-biking. If health and safety effects are assumed equal for e-biking and ordinary bicycling, the shift between the two does not affect the CBA; but if ordinary bicycling and walking have higher net benefit per km, when aggregating positive health effects and safety effects, a shift to e-biking yields a loss. Policies to bring about increases in bicycling or e-biking will not be only a shift from car to pedelec (Rabl and de Nazelle, 2012, Gössling and Choi, 2015). As shown in the data from Sundfør and Fyhri (2022), that we apply, the e-bike subvention yielded considerable shifts from walking and public transport, not only car driving (Table 2). Targeting those groups that might be more likely to shift from car driving to cycling (Surborg et al., 2001, Sundfør and Fyhri, 2017) can increase the share shifting from car driving, but it will also increase the implementation costs.

The sensitivity analyses that altered the assumptions for car fuel technology distributions, public transport occupancy, and road travel congestion had relatively limited impact on the CBA. Lower congestion shares, for cars and public transport, would reduce slightly the total benefits of the e-bike subvention programme, while lower public transport occupancy would yield a slight increase. In our analysis we downscaled the external costs of travel by petrol and diesel cars, as well as bus travel (Table 1), based on the internalisation of external costs via fuel taxes (Rødseth et al., 2019). The internalisation of negative external effects in Norway is limited, and the internalisation rate is currently zero for electric cars. Thus, when the share of electric cars is increased, there are opposing impacts on the CBA; a reduced cost of CO_2 emission but increased non-internalised cost of congestion. Although limited, we found that the internalisation of external effects via distance-based taxes was considerable enough to be taken account of in our CBA.

6. Conclusions

Financial incentives can contribute to a boost in cycling/e-biking (Martin et al., 2012, Sundfør and Fyhri, 2017, Sundfør and Fyhri, 2022, Ciccone et al., 2021). Our CBA indicates that a simplistic organization of such programmes, e.g., a first-come first-served qualification, can bring the implementation costs down to levels such that it yields positive net benefits. Obviously, that implies that also the fit and wealthy can qualify for a subsidy, which the programme was criticised for.[9] However, assessing the programme with respect to the impact on active transport, disregarding the issue of wealth distribution, the e-bike project seemingly has shown a potentially successful way of pushing daily travel towards more sustainability. Additional CBA studies of similar projects are warranted, preferably also including longer-term effects.

What is also important for impact assessment and policy analysis is the methodological approach and what assumptions are applied for the analysis. We have discussed important methodological issues and specified the comprehensive set of assumptions. A large number of assumptions is necessary for impact assessment and CBA, whether the assumptions are spelled-out or not. The assumptions about health impacts of active travel, the economic valuation (external vs. external plus internal), as well as the relative differences between e-biking, ordinary bicycling, and walking, remain decisive for policy analysis, impact assessment and CBA.

The results of the CBA are most strongly impacted by an addition of internal impacts, the private gains/losses of the individuals. The large money value per km, of internal health gains to pedestrians, relative to the internal health gains per km to cyclists (ordinary bicycles and pedelec e-bikes), in the official Norwegian valuations (NPRA, 2021), will tilt the overall benefits downwards when the policy yields shift from walking to cycling. In our main CBA approach, we have disregarded these internal health and injury impacts, as we consider that individuals are informed about potential health gains and injury risks and take these into account, together with travel time and other features, in their transport mode choice (Börjesson and Eliasson, 2012, van Wee and Börjesson, 2015, Flügel et al., 2021). Thus, we have argued for a different approach to the analysis compared to former literature and the current official approach in Norway, while also comparing our selected approach to the more customary assumptions, in sensitivity analyses. We call for more studies that discuss the impact assessment of bicycle and active travel promotion.

CRediT authorship contribution statement

Knut Veisten: Conceptualization, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing. **Aslak Fyhri:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition. **Askill Harkjerr Halse:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Hanne Beate Sundfør:** Investigation, Funding acquisition, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

Our study was funded via the project *Finding Routes to Active Mobility in Everyday life through Digitalization* (FRAME-D), no. 283321/O80, under the TRANSPORT programme of the Research Council of Norway (Norges forskningsråd); the survey data on e-bike purchase was financed by the Oslo City Council. We acknowledge the inputs from Christian Weber. We also acknowledge the helpful comments and proposals to our manuscript from three anonymous reviewers to this journal.

Recommended articles

Data availability

Data will be made available on request.

References

Angrist and Pischke, 2008 J. Angrist, J.S. Pischke
Mostly Harmless Econometrics
Princeton University Press, Princeton NJ (2008)
Google Scholar

Bauman et al., 2008 Bauman, A., Rissel, C., Garrard, J., Kerr, I., Speidel, R., & Fishman, E. (2008). Cycling: Getting Australia moving - barriers, facilitators and interventions to get more Australians physically active through cycling. Department of Health and Ageing, Melbourne (https://catalogue.nla.gov.au/catalog/6338240).
Google Scholar

Beale et al., 2012 S.J. Beale, M.W. Bending, P. Trueman, B. Naidoo
Should we invest in environmental interventions to encourage physical activity in England? An economic appraisal
Eur. J. Pub. Health, 22 (6) (2012), pp. 869-873
CrossRef View in Scopus Google Scholar

Berntsen et al., 2017 Berntsen, S., Malnes, L., & Langaker, A. (2017). Physical activity when riding an electric assisted bicycle. *International Journal of Behavioral Nutrition and Physical Activity*, 14:55, 7 p. (https://doi.org/10.1186/s12966-017-0513-z).
Google Scholar

Bertelsen et al., 2021 Bertelsen, D., Landmark, A.D., Kroksæter, A., & Johansen, J.M. (2021). Gjennomgang av slitasjekostnader for godstransport på veg og jernbane. SINTEF Report 2021:00476, Trondheim (https://sintef.brage.unit.no/sintef-xmlui/bitstream/handle/11250/2757182/2021-

00476%2BGjennomgang%2Bav%2Bslitasjekostnader%2Bfor%2Bgodstransport%2Bp%25C3%25A5%2Bveg%2Bog%2Bjernbane.pdf?sequence=1&isAllowed=y ↗, last accessed 18 Dec 2023).

Google Scholar ↗

Bickel and Friedrich, 2005 Bickel, P. & Friedrich, R. (Eds.) (2005). ExternE—Externalities of energy: Methodology 2005 update. Office for Official Publications of the European Communities, Luxembourg (https://op.europa.eu/de/publication-detail/-/publication/b2b86b52-4f18-4b4e-a134-b1c81ad8a1b2 ↗, last accessed 18 Dec 2023).

Google Scholar ↗

Bickel and Friedrich, 2001 P. Bickel, R. Friedrich (Eds.), Environmental External Costs of Transport, Springer Verlag, Heidelberg BW (2001)

Google Scholar ↗

Bjørnskau, 2018 Bjørnskau, T. (2018). Will the zero-growth objective lead to more traffic injuries? TØI Report 1631/2018, Institute of Transport Economics (TØI), Oslo (in Norwegian with a summary in English).

Google Scholar ↗

Börjesson and Eliasson, 2012 M. Börjesson, J. Eliasson

The value of time and external benefits in bicycle appraisal

Transp. Res. A Policy Pract., 46 (4) (2012), pp. 673-683

View PDF View article View in Scopus ↗ Google Scholar ↗

Bunde, 1997 J. Bunde

The BikeBusters from Århus, Denmark: “We'll park our cars for 200 years”

R. Tolley (Ed.), The Greening of Urban Transport: Planning for Walking and Cycling in European Cities (2nd ed.), Wiley, London (1997), pp. 373-377

Google Scholar ↗

Cairns et al., 2017 S. Cairns, F. Behrendt, D. Raffo, C. Beaumont, C. Kiefer

Electrically-assisted bikes: potential impacts on travel behaviour

Transp. Res. A Policy Pract., 103 (2017), pp. 327-342

View PDF View article View in Scopus ↗ Google Scholar ↗

Castro et al., 2019 Castro, A., Gaupp-Berhausen, M., Dons, E., Standaert, A., Laeremans, M., Clark, A., Anaya-Boig, E., Cole-Hunter, T., Avila-Palencia, I., Rojas Rueda, D., Nieuwenhuijsen, M., Gerike, R., Panis, L.I., de Nazelle, A., Brand, C., Raser, E., Kahlmeier, S., & Götschi, T. (2019). Physical activity of electric bicycle users compared to conventional bicycle users and non-cyclists: insights based on health and transport data from an online survey in seven European cities. *Transportation Research Interdisciplinary Perspectives*, 1:100017, 10 p. (https://doi.org/10.1016/j.trip.2019.100017 ↗).

Google Scholar ↗

Ciccone et al., 2021 A. Ciccone, A. Fyhri, H.B. Sundfør

Using behavioral insights to incentivize cycling: results from a field experiment

J. Econ. Behav. Organ., 188 (2021), pp. 1035-1058

View PDF View article Google Scholar

Cleland et al., 2023 C.L. Cleland, S. Jones, M. Moeinaddini, H. Weir, F. Kee, J. Barry, A. Longo, G. McKeown, L. Garcia, R.F. Hunter
Complex interventions to reduce car use and change travel behaviour: an umbrella review
J. Transp. Health, 31 (2023), 10.1016/j.jth.2023.101652
Google Scholar

Colditz, 1999 Colditz, G.A. (1999). Economic costs of obesity and inactivity. Medicine & Science in Sports & Exercise, 31(11, Suppl), S663–S667.
Google Scholar

Cook and Campbell, 1979 T.D. Cook, D.T. Campbell
Quasi-Experimentation: Design & Analysis for Field Settings
Rand McNally, Chicago IL (1979)
Google Scholar

Cope et al., 2003 A. Cope, S. Cairns, K. Fox, D.A. Lawlor, M. Lockie, L. Lumsdon, C. Riddoch, P. Rosen
The UK national cycle network: an assessment of the benefits of sustainable transport infrastructure
World Transp. Policy Pract., 9 (1) (2003), pp. 6-17
CrossRef Google Scholar

Dagsavisen, 2016 Dagsavisen (2016). Stor interesse for støtteordning for elsykkel i Oslo (Great interest in a subsidy scheme for electric bicycles in Oslo). News release, 6 Jan 2016, Dagsavisen (https://www.dagsavisen.no/oslo/nyheter/2016/01/06/stor-interesse-for-stotteordning-for-elsykkel-i-oslo/, last accessed 18 Dec 2023).
Google Scholar

Dasgupta and Pearce, 1972 A.K. Dasgupta, D.W. Pearce
Cost-Benefit Analysis: Theory and Practice
Macmillan Press, London/Basingstoke (1972)
Google Scholar

de Hartog et al., 2010 J.J. de Hartog, H. Boogaard, H. Nijland, G. Hoek
Do the health benefits of cycling outweigh the risks?
Environ. Health Perspect., 118 (8) (2010), pp. 1109-1116
CrossRef View in Scopus Google Scholar

Didriksen, 2017 Figenschou & Didriksen (2017). Byrådet sponser elektriske varesykler (The City Government sponsors electric cargo bikes). News release, 30 Jan 2017, Norwegian Broadcasting Corporation (NRK), Oslo (https://www.nrk.no/osloogviken/byradet-sponser-elektriske-varesykler-1.13348655, last accessed 18 Dec 2023).
Google Scholar

Elvik, 1994 R. Elvik

The external costs of traffic injury: definition, estimation, and possibilities for internalization

Accid. Anal. Prev., 26 (6) (1994), pp. 719-732

View PDF View article View in Scopus ↗ Google Scholar ↗

Elvik, 2013 R. Elvik

A re-parameterisation of the Power Model of the relationship between the speed of traffic and the number of accidents and accident victims

Accid. Anal. Prev., 50 (2013), pp. 854-860

View PDF View article View in Scopus ↗ Google Scholar ↗

EU ministers for Transport, 2015 EU ministers for Transport (2015). Declaration on cycling as a climate friendly transport mode. Luxembourg, October 7th, 2015. Ministère du Développement Durable et des Infrastructures, Luxembourg. (Retrieved from https://www.benelux.int/fr/publication/european-cycling-declaration/ ↗, last accessed 18 Dec 2023).

Google Scholar ↗

Eurostat, 2022 Eurostat (2022). Hourly labour costs. Eurostat, Brussels (retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Hourly_labour_costs ↗, last accessed 18 Dec 2023).

Google Scholar ↗

Fishman and Cherry, 2016 E. Fishman, C. Cherry

E-bikes in the mainstream: reviewing a decade of research

Transp. Rev., 36 (1) (2016), pp. 72-91

View article CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Flügel et al., 2021 Flügel, S., Veisten, K., Sundfør, H.B., Jordbakke, G.N., Hulleberg, N., & Halse, A.H. (2021). The effect of health benefits on the value of travel time savings in active transport. Journal of Transport & Health, 21:101074: 15 p. (https://doi.org/10.1016/j.jth.2021.101074 ↗).

Google Scholar ↗

Fyhri et al., 2016 Fyhri, A., Sundfør, H.B., & Weber, C. (2016). Effect of subvention program for electric bicycle in Oslo on bicycle use, transport distribution and CO_2 emissions. TØI Report 1498/2016, Institute of Transport Economics (TØI), Oslo.

Google Scholar ↗

Fyhri et al., 2019 Fyhri, A., Johansson, O. & Bjørnskau, T. (2019). Gender differences in accident risk with e-bikes—Survey data from Norway. Accident Analysis & Prevention, 132: 105248, 8 p. (https://doi.org/10.1016/j.aap.2019.07.024 ↗).

Google Scholar ↗

Fyhri and Fearnley, 2015 A. Fyhri, N. Fearnley

Effects of e-bikes on bicycle use and mode share

Transp. Res. Part D: Transp. Environ., 36 (2015), pp. 45-52

View PDF View article View in Scopus ↗ Google Scholar ↗

Fyhri et al., 2017 A. Fyhri, E. Heinen, N. Fearnley, H.B. Sundfør
A push to cycling—exploring the e-bike's role in overcoming barriers to bicycle use with a survey and an intervention study
Int. J. Sustain. Transp., 11 (9) (2017), pp. 681-695
View article CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Gojanovic et al., 2011 B. Gojanovic, J. Welker, K. Iglesias, C. Daucourt, G. Gremion
Electric bicycles as a new active transportation modality to promote health
Med. Sci. Sports Exerc., 43 (2011), pp. 2204-2210
View in Scopus ↗ Google Scholar ↗

Gordon et al., 2004 Gordon, P.M., Zizzi, S.J., Pauline, J. (2004). Use of a community trail among new and habitual exercisers: a preliminary assessment. Preventing Chronic Disease, 1(4): A11, 11 p. (https://www.cdc.gov/pcd/issues/2004/oct/pdf/04_0058.pdf ↗).
Google Scholar ↗

Gössling and Choi, 2015 S. Gössling, A.S. Choi
Transport transitions in Copenhagen: comparing the cost of cars and bicycles
Ecol. Econ., 113 (2015), pp. 106-113
View PDF View article View in Scopus ↗ Google Scholar ↗

Götschi, 2011 T. Götschi
Costs and benefits of bicycling investments in Portland, Oregon
J. Phys. Act. Health, 8 (Suppl 1) (2011), pp. S49-S58
CrossRef ↗ Google Scholar ↗

Götschi and Hintermann, 2014 T. Götschi, B. Hintermann
Valuing public investments to support bicycling
Swiss Journal of Economics and Statistics, 150 (4) (2014), pp. 297-329
View in Scopus ↗ Google Scholar ↗

Grue et al., 2021 Grue, B, Landa-Mata, I., & Flotve, B.L. (2021). Den nasjonale reisevaneundersøkelsen 2018/19 - nøkkelrapport. TØI Report 1835/2021, Institute of Transport Economics (TØI), Oslo. (In Norwegian with a summary in English).
Google Scholar ↗

Hiselius and Svensson, 2017 L.W. Hiselius, Å. Svensson
E-bike use in Sweden – CO_2 effects due to modal change and municipal promotion strategies
J. Clean. Prod., 141 (2017), pp. 818-824
Google Scholar ↗

Hjorthol et al., 2014 Hjorthol, R., Engebretsen, Ø., & Uteng, T.P. (2014). Den nasjonale reisevaneundersøkelsen 2013/14 - nøkkelrapport. TØI Report 1383/2014, Institute of Transport Economics (TØI), Oslo. (In Norwegian with a summary in English).

Google Scholar ↗

Hunkin and Krell, 2019 S. Hunkin, K. Krell
Promoting active modes of transport - A policy brief from the policy learning platform on low-carbon economy
Interreg Europe, European Union, Lille (2019)

Google Scholar ↗

Kahlmeier et al., 2017 Kahlmeier, S., Götschi, T., Cavill, N., Castro Fernandez, A., Brand, C., Rojas Rueda, D., Woodcock, J., Kelly, P., Lieb, C., Oja, P., Foster, C., Rutter, H. & Racioppi, F. (2017). Health economic assessment tool (HEAT) for walking and for cycling: methods and user guide on physical activity, air pollution, injuries and carbon impact assessments. World Health Organization, WHO Regional Office for Europe, Copenhagen. (https://iris.who.int/bitstream/handle/10665/344136/9789289052788-eng.pdf?sequence=1&isAllowed=y ↗, last accessed 12 Oct 2023).

Google Scholar ↗

Kasnatscheew et al., 2018 A. Kasnatscheew, S. Schönebeck, F. Heinl, K. Rabjerg Meltofte, L. Hiselius, P. Vilar i Ribó, K. Veisten
Considering vulnerable road users in accident cost calculation. InDeV Deliverable 5.3, In-depth understanding of accident causation for vulnerable road users (InDeV)
Project Funded by the European Commission under the Horizon 2020 Framework Programme, Bundesanstalt Für Straßenwesen (BASt), Bergisch Gladbach NRW (2018)

Google Scholar ↗

KlimaOslo, 2023 KlimaOslo (2023). KlimaOslo (2023). Elektriske lastesykler (Electric cargo bikes). KlimaOslo, Oslo City Government (https://klimatilskudd.no/elektriske-lastesykler?fbclid=IwAR24weSD6ph4lJ6NT-AlOCM0ASF19eUcKJXGNyQIdhPbA-5VcY1XsnuTESQ ↗, last accessed 18 Dec 2023).

Google Scholar ↗

Kornas et al., 2017 K. Kornas, C. Bornbaum, C. Bushey, L. Rosella
Exploring active transportation investments and associated benefits for municipal budgets: a scoping review
Transp. Rev., 37 (4) (2017), pp. 465-487

View article CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Lund, 2019 Lund, J. (2019). Helsevesenbasert skaderegistrering som verktøy for å forebygge trafikkulykker - Status på feltet og forslag til hvordan trafikkulykkesdata kan registreres. Mai 2019, Trygg Trafikk, Oslo.

Google Scholar ↗

Lunke and Grue, 2018 Lunke, E.B., & Grue, B. (2018) Sykling og sykkelmål. TØI Report 1676/2018, Institute of Transport Economics (TØI), Oslo. (In Norwegian with a summary in English).

Google Scholar ↗

Mamoli, 2003 M. Mamoli

Promoting cycling in Italian cities: the case of Padua

R. Tolley (Ed.), Sustainable Transport: Planning for Walking and Cycling in Urban Environments, Woodhead Publishing, Cambridge (2003), pp. 670-678

View PDF View article View in Scopus ↗ Google Scholar ↗

Martin et al., 2012 A. Martin, M. Suhrcke, D. Ogilvie

Financial incentives to promote active travel: An evidence review and economic framework

Am. J. Prev. Med., 43 (6) (2012), pp. e45-e57

View PDF View article View in Scopus ↗ Google Scholar ↗

McVicar et al., 2022 J. McVicar, M.A. Keske, R. Daryabeygi-Khotbehsara, A.C. Betik, L. Parker, R. Maddison

Systematic review and meta-analysis evaluating the effects electric bikes have on physiological parameters

Scand. J. Med. Sci. Sports, 32 (7) (2022), pp. 1076-1088

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Meschik, 2012 M. Meschik

Reshaping city traffic towards sustainability—Why transport policy should favor the bicycle instead of car traffic

Procedia. Soc. Behav. Sci., 48 (2012), pp. 495-504

View PDF View article Google Scholar ↗

Mishan and Quah, 2020 E.J. Mishan, E. Quah

Cost-Benefit Analysis

(6th ed.), Routledge, London / New York (2020)

Google Scholar ↗

Newbery, 1990 D.M. Newbery

Pricing and congestion: economic principles relevant to pricing roads

Oxf. Rev. Econ. Policy, 6 (2) (1990), pp. 22-38

CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Newbery, 1992 D.M. Newbery

Should carbon taxes be additional to other fuel transport taxes?

Energy J., 13 (2) (1992), pp. 49-60

CrossRef ↗ Google Scholar ↗

Npra, 2018 NPRA (2018). Konsekvensanalyser. Håndbok V712, Statens vegvesen / Vegdirektoratet (Norwegian Public Roads Administration), Oslo.

Google Scholar

NPRA, 2021 NPRA (2021). Konsekvensanalyser (2018-versjon, oppdatert 2021). Håndbok V712, Statens vegvesen / Vegdirektoratet (Norwegian Public Roads Administration), Oslo. (https://www.vegvesen.no/globalassets/fag/handboker/hb-v712-konsekvensanalyser-2021.pdf, last accessed 18 Dec 2023).

Google Scholar

NRD, 2023 NRD (2023). Dokumentasjon av SAGA. Versjon 2.8, Jernbanedirektoratet (Norwegian Railway Directorate), Oslo. (https://www.jernbanedirektoratet.no/content/uploads/2023/11/dokumentasjon-av-saga-v2_8.pdf, last accessed 18 Dec 2023).

Google Scholar

Poos et al., 2017 Poos, H.P.A.M., Lefarth, T.L., Harbers, J.S., Wendt, K.W., El Moumni, M. & Reininga, I.H.F. (2017). E-bikers raken vaker ernstig gewond na fietsongeval: resultaten uit de Groningse fietsongevallendatabase. (E-bikers are more often seriously injured in bicycle accidents: results from the Groningen bicycle accident database), *Nederlands Tijdschrift voor Geneeskunde*, 161:D1520. (https://www.ntvg.nl/artikelen/e-bikers-raken-vaker-ernstig-gewond-na-fietsongeval).

Google Scholar

Pucher et al., 2011 J. Pucher, R. Buehler, M. Seinen

Bicycling renaissance in North America? An update and re-appraisal of cycling trends and policies

Transp. Res. A Policy Pract., 45 (6) (2011), pp. 451-475

View PDF View article View in Scopus Google Scholar

Rabl and de Nazelle, 2012 A. Rabl, A. de Nazelle

Benefits of shift from car to active transport

Transp. Policy, 19 (2012), pp. 121-131

View PDF View article View in Scopus Google Scholar

Rødseth et al., 2019 Rødseth, K.L., Wangsness, P.B, Veisten, K., Høye, A.K., Elvik, R., Klæboe, R., Thune-Larsen, H., Fridstrøm, L., Lindstad, E., Rialland, A., Odolinski, K., & J.E. Nilsson (2019). The external costs of transport—Marginal damage cost estimates for passenger and freight transport in Norway. TØI Report 1704/2019, Institute of Transport Economics (TØI), Oslo. (In Norwegian with a summary in English).

Google Scholar

Rojas-Rueda et al., 2016 Rojas-Rueda, D., de Nazelle, A., Andersen, Z.J., Braun-Fahrländer, C., Bruha, J., Bruhova-Foltynova, H., Desqueyroux, H., Praznoczy, C., Ragettli, M.S., Tainio, M., & Nieuwenhuijsen, M.J. (2016) Health impacts of active transportation in Europe. PLoS ONE, 11(3): e0149990, 14 p. (https://doi.org/10.1371/journal.pone.0149990).

Google Scholar

Sælensminde, 2004 K. Sælensminde
Cost–benefit analyses of walking and cycling track networks taking into account insecurity, health effects and external costs of motorized traffic
Transp. Res. A Policy Pract., 38 (2004), pp. 593-606
View PDF View article View in Scopus Google Scholar

Sælensminde and Bryde-Erichsen, 2017 Sælensminde, K. & Bryde-Erichsen, K.D. (2017). Verdi på et kvalitetsjustert leveår (QALY) for sektorovergripende anvendelse i nytte-kostnadsanalyser – Eksempler på anvendelse for ulike skadegrader ved ulykker, luftforurensning, støy og fysisk aktivitet. Notat, 04.05.2017, Helsedirektoratet (Norwegian Directorate of Public Health), Oslo. (34 p.).
Google Scholar

Standen et al., 2019 C. Standen, S. Greaves, A.T. Collins, M. Crane, C. Rissel
The value of slow travel: Economic appraisal of cycling projects using the logsum measure of consumer surplus
Transp. Res. A Policy Pract., 123 (2019), pp. 255-268
View PDF View article View in Scopus Google Scholar

Sturm, 2004 R. Sturm
The economics of physical activity: societal trends and rationales for interventions
Am. J. Prev. Med., 27 (3S) (2004), pp. 126-135
View PDF View article View in Scopus Google Scholar

Sundfør and Fyhri, 2017 Sundfør, H.B., & Fyhri, A. (2017). A push for public health: the effect of e-bikes on physical activity levels. *BMC Public Health*, 17:809, 12 p. (https://doi.org/10.1186/s12889-017-4817-3).
Google Scholar

Sundfør and Fyhri, 2022 Sundfør, H.B., & Fyhri, A. (2022). The effects of a subvention scheme for e-bikes on mode share and active mobility. Journal of Transport & Health, 26:101403, 12 p. https://doi.org/10.1016/j.jth.2022.101403 .
Google Scholar

Sundfør et al., 2023 H.B. Sundfør, S. Berntsen, E.T. Bere, A. Fyhri
The effects of subsidising e-bikes on mode share and physical activity -
a Natural Experiment, Unpublished manuscript, Institute of Transport Economics, Oslo (2023)
Google Scholar

Surborg et al., 2001 Surborg, B., Boddy, S., & Kassirer, J. (2001). Århus Bike Bus'ters. Case Study, Tools of Change (https://www.toolsofchange.com/en/case-studies/detail/131 , last accessed 18 Dec 2023).
Google Scholar

Sutton, 2017 Sutton, M. (2017). Oslo handing citizens $1,200 for electric cargo bike purchases. 2 Feb 2017, Cycling Industry News (https://cyclingindustry.news/oslo-handing-citizens-1200-for-electric-cargo-bike-purchases/ , last accessed 18 Dec 2023).

Google Scholar ↗

Synek and Koenigstorfer, 2018 S. Synek, J. Koenigstorfer
Exploring adoption determinants of tax-subsidized companyleasing bicycles from the perspective of German employers and employees
Transp. Res. A Policy Pract., 117 (2018), pp. 238-260
View PDF View article View in Scopus ↗ Google Scholar ↗

van Wee and Börjesson, 2015 B. van Wee, M. Börjesson
How to make CBA more suitable for evaluating cycling policies
Transp. Policy, 44 (2015), pp. 117-124
View PDF View article View in Scopus ↗ Google Scholar ↗

Veisten et al., 2007 K. Veisten, K. Sælensminde, K. Alvær, T. Bjørnskau, R. Elvik, T. Schistad, B. Ytterstad
Total costs of bicycle injuries in Norway: correcting injury figures and indicating data needs
Accid. Anal. Prev., 39 (6) (2007), pp. 1162-1169
View PDF View article View in Scopus ↗ Google Scholar ↗

Veisten et al., 2011 K. Veisten, S. Flügel, F. Ramjerdi, H. Minken
Cycling and walking for transport: estimating net health effects from comparison of different transport mode users' self-reported physical activity
Heal. Econ. Rev., 1 (3) (2011), p. 9, 10.1186/2191-1991-1-3 ↗
Google Scholar ↗

Wang et al., 2004a G. Wang, C.A. Macera, B. Scudder-Soucie, T. Schmid, M. Pratt, D. Buchner, G. Heath
Cost analysis of the built environment: the case of bike and pedestrian trials in Lincon
Neb. *American Journal of Public Health*, 94 (2004), pp. 549-553
View in Scopus ↗ Google Scholar ↗

Wang et al., 2004b G. Wang, M. Pratt, C.A. Macera, Z.J. Zheng, G. Heath
Physical activity, cardiovascular disease, and medical expenditures in U.S. adults
Ann. Behav. Med., 28 (2) (2004), pp. 88-94
CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Wardman et al., 2007 M. Wardman, M. Tight, M. Page
Factors influencing the propensity to cycle to work
Transp. Res. A Policy Pract., 41 (4) (2007), pp. 339-350
View PDF View article View in Scopus ↗ Google Scholar ↗

Winters et al., 2017 M. Winters, R. Buehler, T. Götschi
Policies to promote active travel: evidence from reviews of the literature
Current Environmental Health Reports, 4 (2017), pp. 278-285
CrossRef ↗ View in Scopus ↗ Google Scholar ↗

Cited by (0)

1 We consider only e-bikes that are classified as bicycles with access to the bicycle infrastructure within the European Union / European Economic Area (EN 15,194 Standard); that is, e-bikes, or pedelecs, with a maximum power assistance to the pedalling of 250 Watt, and the power assistance ceases when the speed surpasses 25 km/h (Meschik, 2012; Fishman & Cherry, 2016).

2 Synek & Koenigstorfer (2018) describe a very interesting bicycle leasing tax subsidy for employees and their companies, introduced in 2012, whereby employees can lease bicycles for three years and then having the option of purchasing the bicycle for its residual value. After a bit more than four years, 200,000 employees had leased bicycles under the tax subsidy programme. Unfortunately, no estimates on the impact on transport mode choice are reported.

3 The difference-in-differences method is based on the assumption of similar underlying trends in the groups that are compared (Angrist & Pischke, 2008, p. 169-182). A simple version of the method yields the following expression for the change in the intervention group, R, relative to the comparison group, C: ((–pre-level-R)–(–post-level-R))–((–pre-level-C)–(–post-level-C)).

4 Supposedly, there was also a contribution to the price reduction (the subsidy) from the retailer; the average transfer from the municipality/consultancy per purchase is €125 based on the figures in Table 3. We assume the ordinary prices of the purchased e-bikes were higher than €625 on average.

5 Hiselius and Svensson (2017), in a study from Sweden on CO_2-emission impacts from a shift to e-biking, applied a cycle season interval of 33.2 weeks (about 230 days) to 48 weeks (nearly 340 days).

6 Applying directly the rounded values in Table 5 would yield, respectively €60,060 and €64,680.

7 There were some differences in reported cycle season length between the groups: C had an average of 207, CR 156, and R an average of 147. We fix the cycle season length across groups for the CBA, as we do not find reason for a shift in cycle season length following from a purchase and use of an e-bike. But we test the impact of shortening the cycle season for all groups, from an average of 200 to an average of 150.

8 The result is partially due to the change in official valuations of active travel, between 2018 and 2021 (NPRA, 2018; NPRA, 2021). However, as the former higher official valuations of internal health gains had a larger relative difference between the walking and cycling, the resulting estimated net benefit of the e-bike subvention programme would have been lower compared to the results under our main assumptions.

9 In spite of the criticism, the Oslo City Government launched a similar campaign in early 2017, comprising electric cargo bikes (Figenschou & Didriksen, 2017; Sutton, 2017). In 2020, a third e-bike subvention programme, that also included a parallel research study (Sundfør et al., 2023). In the summer of 2023, the Oslo City Government re-launched the electric cargo bike subvention scheme for private households, but then applying lottery-based selection instead of first come, first served (KlimaOslo, 2023).