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Can we become car-free in just one month? Evidence from Switzerland

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ABSTRACT

We analyse a mobility trial performed in 2024 in the Swiss city of Winterthur: voluntary participants were invited not to use their car for one month, and provided with free access to e-bikes, public transport, and car-sharing. Using a mixed-methods pretest-posttest design based on surveys ($n = 257$) and focus groups ($n = 43$), we estimate the short-term effects on car use intention and car ownership. The trial mostly attracted individuals already into the transition to “car-freedom”. It reduced frequent car use intention in 36 % of the participants, with greater effect (54 %) in those at early transition phases. It also reduced car ownership, though limitedly: immediately after the trial 2 % of the households became car-free. Two months later, car-free households increased to 13 %, also thanks to generous municipal car-selling incentives. Our results strengthen the findings by recent trials, suggesting partial substitution effects between car and its alternatives.

1. Introduction

Current Western societies are shaped as “systems of automobility” (Urry, 2004): whole socio-technical systems built around the car and fully grounded in its use. The automobility system has, however, long been questioned, due to its environmental and social impacts: greenhouse gas emissions, air pollution, noise, soil sealing, morbidity and mortality due to accidents, health problems due to physical inactivity, and general decrease in quality of life due to congestion (Gössling et al., 2007; Parry et al., 2007; Banister, 2005). Meeting sustainability goals thus calls for overcoming the current “automobile dependence” (Newman and Kenworthy, 1989) and for transitioninig to a “post-car” system (Dennis and Urry, 2009).

Many scholars argued that successful strategies to reduce car use should include both measures aimed at discouraging car use, making it more costly, slower, and generally less convenient, and measures aimed at increasing the appeal of alternatives to cars, by improving the safety, convenience, and feasibility of walking, cycling, and public transport (see for instance Buehler et al. 2017, Loder et al. 2023, 2024). Indeed, transitioning to post-car systems requires coordinated action on both material and immaterial factors (Baehler and Rérat, 2022). The former deal with infrastructures for mobility (e.g. safe cycling lanes, time- and cost-effective public transport services, low-speed areas) and land planning measures (e.g. prioritising dense urban spaces and proximity concepts, ensuring that daily life services and urban functions, leisure ones included, can be reached by walking, cycling, or short public transport rides). The latter deal with social norms and shared cultural meanings that support car-free lifestyles.

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1.1. Car-free households

Previous research already investigated the characteristics of zero-car households, their motivations, and their practices. The literature distinguishes between "car-less" households, that do not own a car out of necessity, and "car-free" households, that would be able to buy, maintain, and drive a car, yet consciously and explicitly choose not to own one (Brown, 2017). When dealing with the transition to post-car systems, the focus is on the latter group, namely households that voluntarily decide not to use or own a car.

By investigating Australian car-free households, Paijmans and Pojani (2021) found that they are well-educated, middle-class households, looking for personal-level benefits regarding health, fitness, convenience, and monetary savings. Although important, collective benefits (including environmental ones such as improving air quality or mitigating climate change) are less relevant for their decision to car-free living. This is coherent with previous research on pro-environmental behaviour and car use, such as for instance the works by Eriksson and Forward (2011) and Pojani et al. (2018).

Based on such findings, Paijmans and Pojani (2021) suggest campaigns for car-free lifestyles to frame them as sources of fun, pleasure, ease, and well-being, rather than sacrifices to protect the environment. Similarly, Moser et al. (2016) argue that strategies to reduce car use and increase e-bikes uptake should emphasise benefits like fun, fitness, and improved health, besides the ecological ones. Similarly, Söderberg et al. (2021) suggest e-bikes should be promoted by marketing both altruistic and hedonic reasons, as they are appreciated for both environmental and personal benefits (e.g., speed, saving money, increasing exercise, and well-being).

1.2. The Winterthur 31DAYS Challenge

The above principles underlie the "31DAYS Challenge", a trial performed in 2024 in the Swiss city of Winterthur. Designed and launched by the "42hacks" social innovation startup company, the Challenge aimed at spreading novel social norms supportive of multi-modal mobility and car-free lifestyles, by inviting up to 1000 voluntary persons to experience car-free living for one month. Promoted as an opportunity to experience a novel mobility freedom ("Enjoy 31 days of complete freedom by leaving your car"), 31DAYS provided its participants with a free e-bike, free access to public transport, and a car-sharing subscription. In return, participants committed to using their car as little as possible —ideally, never— for the entire month. The costs of the provided mobility services were covered by the City of Winterthur, the Swiss Federal Railways (SBB), e-bike sellers, and Mobility car-sharing.

Winterthur (120'000 inhabitants, the sixth-largest Swiss city) is characterised by an efficient public transport network and widespread coverage by cycling lanes. The 2021 Swiss Mobility and Transport Microcensus in fact estimates at 55 % the share of daily kilometers travelled by individual motorised transport across the Winterthur agglomeration: a low value for Swiss agglomerations, whose average is 70.4 % and worst case is 82.5 % (BFS/ARE, 2023). Since 2014 Winterthur also ranks first in the "Prix Velo Cities" survey investigating the perceived quality of cycling on a sample of more than Swiss 16,500 cyclists. The City can thus count on well developed material and infrastructural factors supporting the transition to a post-car system. However, they aim at halving individual motorised transport by 2040. Action is thus also needed on the immaterial factors that steer car use and ownership.

1.3. Research goals

Challenges like 31DAYS create "trialability" opportunities for experimentation with post-car system innovations (Strömberg et al., 2016, Rogers, 2003): they provide the participants with spaces for trying new car-free behaviours and understanding their requirements, consequences, and possible risks, by always allowing to go back to the original behaviour, with no losses.

By removing financial barriers to alternatives to car use, and by inviting to use them for an entire month, 31DAYS aimed at helping the participants to break their car-use habits and develop new long-lasting behaviours, to be maintained even after removal of the price advantage over car use. Through 31DAYS, participants were not only expected to hands-on experience that car-free living is possible, but also that it is a pleasant, beneficial, socially appreciated, and overall valuable way of living.

Does the Winterthur 31DAYS Challenge meet its expectations? Providing evidence on the effects of 31DAYS is crucial for policy-making and possible replication to other contexts. In this article, we assess if and to what extent the one-month provision of free e-bikes, car-sharing, and public transport subscriptions is effective in i) decreasing car use intention (Research Question RQ1) and ii) decreasing car ownership, possibly leading participants to become car-free households (Research Question RQ2).

To address these questions, we perform survey-based quantitative analyses, enriching them with insights from focus group qualitative analysis. The resulting mixed-method design thus allows us to gain a comprehensive and in-depth understanding of the effects and underlying mechanisms of the Winterthur 31DAYS Challenge. The article is structured as follows: in Section 2 we summarise previous research on trials aimed at reducing car use. Section 3 introduces our methodology to estimate the effects of the Winterthur 31DAYS Challenge. In Section 4 we report our results, which we then discuss in Section 5. In Section 6, we provide our conclusions and recommendations for future research.

2. Related work

A large body of applied research performed in Western countries investigated how to reduce car use by acting on immaterial factors. Mostly grounded in psychology and behavioural disciplines (Arnott et al., 2014; Steg and Tertoolen, 1999; Graham-Rowe et al., 2011), early research studied the effects of interventions that were referred to as "soft policy measures" (Cairns et al., 2008; Bamberg et al., 2011), or "voluntary travel behaviour change programmes" (Chatterjee and Bonsall, 2009). Early trials focused on

Table 1
Summary of previous literature analysing the effects of public transport trials.

Source	Country	Year	Intervention	N	Results
Thøgersen (2009)	Denmark	2002–2023	One-month free public transport subscription.	597	Public transport use doubled during the trial, with a 40 % increase persisting six months after the trial.
Abou-Zeid and Ben-Akiva (2012)	Boston, US & Switzerland	2008	One-week free public transport subscription.	67, 30	US: about 30 % of participants purchased public transport passes. CH: occasional commuting via public transport but no public transport substitution for commuting.
Bull et al. (2021)	Chile	2016–2017	Two-week free public transport subscription.	207	Increase in the number of public transport trips (particularly, new off-peak trips for leisure purposes), but no substitution between public transport and the other transport modes.
Busch-Geertsema et al. (2021)	Germany	2018	Free public transport subscription for state employees.	1294	Relevant increase in use of public transport, for both commuting and other purposes, especially among those that had not subscribed to public transport before. However, no decrease in car use or car ownership.
Sharman et al. (2020)	Tasmania, AU	2019–2020	Weekly goals and targets to win bus fare credit.	68	Increase in the share of bus users and in average weekly amoiunt of bus use.
Brough et al. (2022)	Seattle, US	2019–2020	Up to six-month free public transport subscription for low-income individuals.	1797	Increase in public transport use, though the effect rapidly disappeared after the end of the intervention.
Liebensteiner et al. (2024)	Germany	2022	9 Euro monthly public transport subscription.	N/A	Increase in public transport use, mostly for leisure purposes; no effects on car-based commuting.
Loder et al. (2024)	Germany	2022	9 Euro monthly public transport subscription.	1454, 684	Increase in public transport use, particularly among those who had no public transport travelcards before, but only partial substitution of car trips.
Ortega and Link (2025)	Germany	2022	9 Euro monthly public transport subscription.	276	Car users have the lowest absolute direct elasticity among all travel modes; the temporary intervention on public transport price is not sufficient to address car use inertia.

how to generate substitution effects between car and public transport; later, trials focused on substitution effects between e-bike and car use, and only recently they started to more broadly promote “car-free living”.

2.1. Public transport trials

The literature on the effects of trials offering free public transport shows mixed findings (Table 1): most studies report an increase in public transport use, but in many cases this is due to an increased mobility demand for leisure purposes, rather than a shift from car to public transport. When a substitution takes place, free public transport does not manage to fully substitute car trips with public transport use, especially for commuting trips.

One of the earliest trials was performed in Denmark between 2002 and 2003 by Thøgersen (2009), who provided a random sample of Copenhagen drivers with a one-month free public transport subscription, finding a persistent substitution effect between public transport and car use, maintained also six months after the end of the intervention. The effect was driven by increased attitudes and perceived behavioural control towards public transport. Thus, the author concludes that monetary promotions can not only raise the interest of car drivers, induce them to try public transport, and break their car travel habit, but also durably change their beliefs.

Later research, however, suggests different results. For instance, comparing the effects of one-week free public transport trials performed in 2008 in the US and in Switzerland, Abou-Zeid and Ben-Akiva (2012) conclude that the offer of free public transport best caters to people already inclined to reducing car use, characterised by stronger intention to use public transport, lower satisfaction with car-based commute, less positive perceptions of car flexibility and travel time, and greater commute cost consciousness. This is coherent with the findings by Beale and Bonsall (2007), who argue that free bus passes increase bus use by people that either are already bus users or at least are well-disposed to bus use. Indeed, a recent review by Keblowski (2020) reports about both studies finding that free public transport mostly appeals to cyclists and pedestrians, rather than car drivers, and studies finding that public transport fare abolition did reduce car usage. Research is therefore still needed to clarify the actual impacts of free public transport, and the contextual factors that drive them.

Even though not specifically analysing trials, recent research on the effects of free public transport policies is also interesting for our purposes. For instance, Busch-Geertsema et al. (2021) estimate the effect of the political decision to introduce, in 2018, free public transport subscriptions for state employees of the German state of Hesse. They find a relevant increase in the share of public transport use (particularly among lower income people and those who were not public transport subscribers), but no decrease in

Table 2
Summary of previous literature analysing the effects of e-bike trials.

Source	Country	Year	Intervention	N	Results
Cairns et al. (2017)	United Kingdom	2013	Free e-bike for six to eight weeks.	80	Three-quarters of participants used e-bikes at least once a week, resulting in a 20 % decrease in weekly car distances.
Fyhri and Fearnley (2015)	Norway	2013	Free e-bike for two or four weeks.	66	Increase in the share of cycling trips (+20 %) and in the number of cycling trips and their daily distances.
De Kruijf et al. (2018)	The Netherlands	2013	Monetary incentive for commuting by e-bike.	547	Increase in the share of commuting by e-bike (from 0 % to 73 %). Only half of e-bike trips substituted car use, the other half substituted cycling.
MacArthur et al. (2017)	Oregon, US	2014-2015	Free folding e-bikes for 10 weeks.	155	Increased cycling compared to traditional bicycles, substitution of some car trips.
Moser et al. (2016)	Switzerland	2015	Free e-bike for two weeks, in exchange for car keys.	90	High willingness to decrease car use and buy an e-bike, though low willingness to sell a car.
Moser et al. (2018)	Switzerland	2015	Free e-bike for two weeks, in exchange for car keys.	405	Lower habitual association with car use even one year after the trial.
Plazier et al. (2017)	The Netherlands	2015	Free e-bike for two weeks.	41	Considerable potential for e-bike use among students, though no e-bikes were bought, due to their purchase price.
Sundfør and Fyhri (2022)	Norway	2016	500 euro incentive programme to purchase e-bikes.	382	Increase in the cycling modal share (17-22 %) and in e-bike distances (11.6–19.3 km).
Edge et al. (2018)	Ontario, CAN	2014-2017	Free e-bike ownership in exchange for three-year mobility monitoring.	25	E-bike trips replaced short car trips. No complete substitution due to cold in Winter and need for transporting children and loads.
Bjørnarå et al. (2019)	Norway	2017–2018	Free (e-)bike and trailer for parents with small kids for three months.	36	Increase in cycling frequency (particularly, in e-cycling), decrease in car use frequency, increase in intrinsic motivation for cycling.
Ton and Duives (2021)	The Netherlands	2019	Free e-bikes for eight weeks.	82	Decrease in car use for commuting purposes (from 88 % to 63 % three months after).
Johnson et al. (2023)	California, US	2020-2022	Three e-bike purchase incentive programmes.	41, 67, 509	Decrease in car use, from daily to weekly or monthly car use.
Söderberg et al. (2021)	Sweden	2020	Free e-bikes for five weeks.	65	E-bikes substituted car commuting and car use for other single-purpose trips requiring no people or goods transport, especially in good weather.

car ownership. Similar effects appear for the “9-Euro ticket”: a largely discounted public transport pass allowing access to the whole public transport network across Germany, that was active between June and August 2022. Despite a substantial —and temporary— increase in train trips, Liebensteiner et al. (2024) find that the 9-Euro ticket produces no decrease in car traffic, particularly not in peak commuting times, and argue that car-based commuting is limitedly responsive to the opportunities offered by nearly free public transport. Comparable conclusions are drawn by Loder et al. (2024), who only find partial substitution of car trips and suggest to combine free public transport with measures aimed at pricing private transport or limiting parking supply, and by Ortega and Link (2025), who find that car users have the lowest absolute direct elasticity among all travel modes, and the highest inertia, which cannot be changed by temporary interventions on public transport price.

2.2. E-bike trials

Analyses of the effects of e-bike trials (i.e. temporary interventions offering free or highly incentivised e-bike use) suggest similar conclusions on the reduction in car use and ownership: they find positive substitution effects between car and e-bike use; however, in most cases the substitution is partial, as after the trial both car and e-bike keep being used—and owned. Table 2 reports the key findings and characteristics of the studies we reviewed.

Systematic reviews of interventions specifically aimed at substituting car with e-bike use confirm partial substitution effects— though the authors call for stricter analyses (Scheepers et al., 2014; Fishman and Cherry, 2016; Nosratzadeh et al., 2025). Specifically, a meta-analysis of 38 studies performed between 2006 and 2017 on mode substitution by e-bikes, finds that the e-bikes have higher substitution effects for public transport, followed by conventional bicycle, car, and then walking (Bigazzi and Wong, 2020). Heterogeneity analyses however suggest that in Europe, North America, and Australia the highest substitution effect occurs for cars. The authors also find that recent studies report greater substitution of car and walking, and less substitution of cycling.

Trials also facilitate barriers affecting e-bike use to emerge. For instance, Plazier et al. (2017) argue that, despite perceived speed, ease of use, feeling of independency, and overall enjoyable experience, the diffusion of e-bikes is largely limited by high purchase costs, which make them non-competitive with public transport and cycling. Other studies also remark the difficulty of transporting goods or other people and the challenges of cycling during Winter months (Edge et al., 2018; Söderberg et al., 2021).

Table 3
Summary of previous literature analysing the effects of car-free trials.

Source	Country	Year	Intervention	N	Results
Laakso (2017)	Finland	2015	Six-month free public transport subscriptions against selling one car.	11	Decrease in overall travel distances; six months after, only one household both a car again, due to relocation. Car mostly replaced by public transport, for commuting trips.
van Vessem et al. (2024)	The Flanders (Belgium)	2022	Free public transport, car- and bike-sharing subscription for one month + tips via frequent newsletter.	451	Decrease in car use and substitution by public transport. However, the latter also substituted part of cycling trips.
Possible (2022)	UK (Birmingham, Bristol, Leeds and London)	2022	Discounts and refunding of any mobility costs performed by means of transport different than cars, for three weeks.	10	87 % decrease in the kilometers travelled by car, substituted by public transport and bicycles, though most participants did not sell their car.
Possible (2024)	UK (Oxford)	2024	Discounts and refunding of any mobility costs performed by means of transport different than cars, for three weeks.	12	Intention to keep driving less than before the challenge. Two participants sold their car, one bought an e-bike.

2.3. *Car-free trials*

Table 3 summarises the results of car-free trials performed in the last decade, that provided free public transport subscriptions in combination with car-sharing and/or bike-sharing schemes, with the explicit aim of reducing car ownership. The available evidence suggests that car-free trials reduce car use (mostly for commuting trips), though on average they do not reduce car ownership.

Some of the car-free studies also suggest that, as trials are characterised by opt-in, voluntary application processes, their participants tend to have high intrinsic motivation to reduce car use, negative attitudes towards car use, and positive attitudes towards car alternatives. For instance, Laakso (2017) found that participants to a Finnish car-free trial performed in 2015 could relatively easily replace their car for their commuting trips. Indeed, many of them were already thinking to sell their car before joining the trial. The trial basically helped them to confirm choices they had already made. Furthermore, van Vessem et al. (2024) found that the voluntary participants to a large-scale social media campaign for reducing car use performed in 2022 in Flanders (Belgium) were not representative of the population, having higher levels of education and employment and being more likely than average to own a bicycle and hold public transport and car-sharing subscriptions. Also the participants in the "Going Car Free Challenge" launched in 2022 in Birmingham, Bristol, Leeds, and London (UK) (Possible, 2022), and then in 2024 in Oxford (Possible, 2024), were highly motivated to drive less—mostly for health and wellbeing reasons, i.e. spending less stressful time in a car and making more physical exercise through cycling.

3. Materials and methods

The Winterthur 31DAYS Challenge took place between mid-April and mid-August 2024, and involved four cohorts of self-selected, voluntary participants, whose household owned at least one car. All data collection and management procedures were approved by the Ethics Committee of the University of Applied Sciences and Arts of Southern Switzerland (protocol number 35866).

3.1. *Participant recruitment and trial characteristics*

With a target of 1000 participants over the four cohorts, participants were recruited by means of social media posts, a press release, and newsletter posts by the City of Winterthur, the 42hacks initiators, and the partners funding access to car alternatives. No eligibility criteria were set, apart from owning at least one car in their household. To provide evidence on car ownership, at trial application they were requested to indicate the plate number, and manual checks were then made by trial managers, before acceptance into the trial. Recruitment started in February 2024 and by mid-April 222 adult participants had already been accepted for participation, which allowed to start with the first cohort. Recruitment remained open until mid-July, to fill four cohorts of participants, which were activated on a monthly basis from mid-April to mid-July 2024.

For the whole month associate with the cohort they were part of, each adult participant was offered a public transport travelcard allowing unlimited travel across Switzerland, an e-bike, and a subscription to the Mobility car-sharing, which is the most widespread car-sharing company operating in Switzerland. Note, use of car-sharing was however to be paid by each participant, as 31DAYS only covered for the initial subscription. Instead, the public transport travelcard and the e-bike directly allowed unlimited mobility, with no need for additional contributions by the participants. Even though participants registered individually, all household members had to register for the 31DAYS trial, as they were all users of the car(s) available in the household. Underage people, however, did not receive either the e-bike or the car-sharing subscription, and only received the free public transport travelcard.

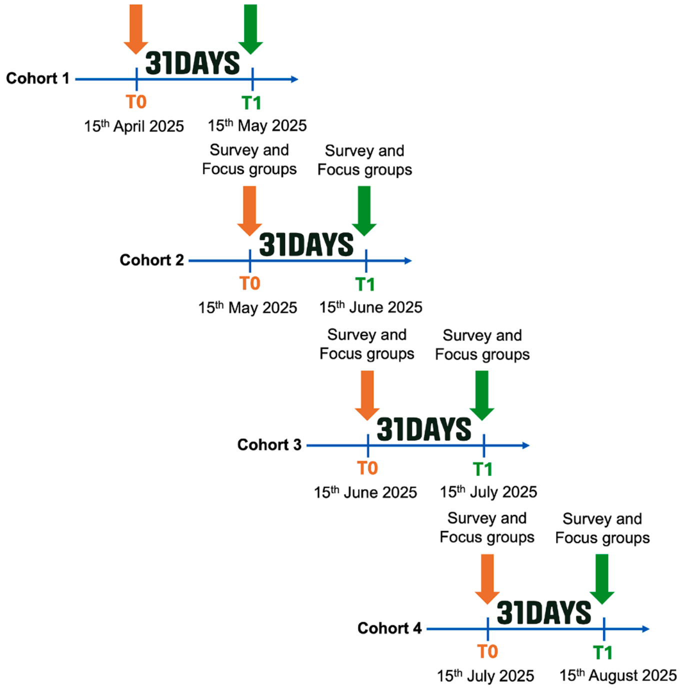

Fig. 1. The timeline of the 31DAYS trial and data collection process.

Doing so, all household members were provided with free alternatives to car-based mobility. Participants were not compelled to use any of those mobility options, and were even free to use their car, in case they needed it. However, they committed to using it as little as possible during the one-month trial period, and to use the new mobility options in order to address their mobility needs.

After the end of the month, participants received an additional communication by the City of Winterthur: the City agreed to offer substantial monetary rewards (3'000 Swiss Francs/Euros) to the participants who, by two months from the end of 31DAYS, would have sold (one of) their household car(s). To benefit from the incentive, participants were required to provide a formal proof they had sold their car, respectively by mid-June 2025 for cohort 1 participants, and by mid-October 2025 for cohort 4 participants.

3.2. Research design

To address our research questions regarding the effect of the Winterthur 31DAYS Challenge, we adopted a mixed-methods one group pretest-posttest research design, by measuring our outcome variables on adult participants before and after participation to 31DAYS, respectively at $T0$ (one week before the start of 31DAYS) and at $T1$ (the week after the end of 31DAYS).

Fig. 1 reports a timeline of overall trial and data collection activities. As we had four cohorts, $T0$ and $T1$ corresponded to four different periods along year 2024. However, they conceptually corresponded to the same conditions before and after 31DAYS. Also, all four cohorts experienced the trial during the Spring-Summer season, which is ideal for cycling: no seasonal effects regarding propensity to cycling and actual cycling feasibility were expected to differentiate outcomes between the four cohorts. Therefore, we grouped all data collected at $T0$ and $T1$, independently on the cohort. Our analyses only considered adult participants, though underage participants were also registered, as all members of the participating households were given free public transport travelcards.

Note, by comparing data collected at $T0$ and $T1$, our analyses allow to estimate the effect of the 31DAYS trial alone, without being affected by the car selling monetary incentives, which was offered by the City of Winterthur only after $T1$. Doing so, we provide more relevant results for future policy-making and applied research: it is likely, in fact, that future interventions manage to raise resources to cover for the trial expenses, but cannot afford offering such generous incentives, which would in theory sum up to more than 2 billion Swiss Francs, by considering the about 750 adult participants.

Via surveys, we measured mobility behaviour and intention (RQ1), vehicle ownership (RQ2), socio-demographics, and psychographic characteristics of the respondents. The surveys were administered online via the Qualtrics software platform, and were sent by email to 31DAYS adult participants via customised links, that ensured the capability to track each user along the $T0$ and $T1$ waves, while preserving the pseudonymisation of all data retrieved from them. Participants were not formally compelled to answer the surveys, though no additional incentives (besides the free access to mobility options) were activated to increase response rates, and two reminders per wave were sent.

To complement insights from the survey-based quantitative analyses, we also conducted focus group discussions with a selection of 31DAYS participants. The aim of the focus groups, which also took place at $T0$ and $T1$ for all cohorts, was to gain in-depth insights into their motivations, attitudes, reasons, and emotions, as well as into the influence of these aspects on their mobility behaviour intention (RQ1) and transport mode ownership (RQ2).

3.3. Research question RQ1: effect on car use intention

To address Research Question RQ1 about car use intention, we measured both mobility behaviour and mobility intention: the survey at $T0$ measured past car use behaviour in the four weeks before 31DAYS, while the survey at $T1$ measured car use intention for the next four weeks after 31DAYS. Specifically, for past car use behaviour at $T0$ we used an ordered categorical variable measuring car use through the following question: “In the last four weeks, how frequently have you used the car?”. For future car use intention at $T1$ we used another ordered categorical variable measured through the following question: “In the next four weeks, how frequently do you plan to use the car?”. In both cases, possible answers were: “Never, “Less than once a week”, “Once a week”, “Several times a week”, “Everyday”.

To detect if possible decreases in car use intention correspond to increases in intentions to use transport modes offered by 31DAYS (e-bike, train, bus and tram, and car-sharing services), we also asked the same questions for those transport modes and created the related binary variables measuring their frequency of use. For public transport, we opted for separating train from bus and tram, as their use might be due to different needs and affected by different constraints: train use might also include long-distance trips, while bus and tram use mostly refers to local trips.

To estimate the effect of 31DAYS on the intention to use each transport mode (RQ1), we compared past use behaviours with future use intentions. Our data-set did not meet the “proportional odds” assumption that characterises ordinal logistic regression models, typically used in similar cases. A Brant test in fact led to reject the null hypothesis of proportional odds on car use frequency data ($\chi^2 = 9.85$, p-value = 0.02). We thus opted for using linear probability regression models and for testing whether, for each transport mode, 31DAYS has an effect on frequent use over the week, and also if it has an effect on any use frequency.

For this purpose, for each transport mode we created two binary variables, respectively representing the “More than once a week” frequency of use (which includes the “Several times a week” and “Everyday” frequencies of use collected via the survey) and the “Once a month or more” frequency of use (which includes all possible frequencies of use collected via the survey, apart from “Never”). Then, for each transport mode and the two recoded frequencies of use, we computed linear probability models as reported in Eq. (1), to directly estimate the average treatment effect (ATE) of 31DAYS:

$$use_{it} = \beta_0 + \beta_1 post_{it} + c_i + \epsilon_{it} \tag{1}$$

where:

- i and t denote the respondents and time (before/after 31DAYS);
- use_{it} is the dependent binary variable measuring respondents- past behaviour and future intention to transport mode use;
- β_1 is the average treatment effect of 31DAYS (ATE);
- $post_{it}$ is the independent binary variable distinguishing between past behaviour measures taken before 31DAYS and future intention measures taken after 31DAYS.

For instance, by considering the “car” transport mode and the “More than once a week” frequency, the dependent binary variable use_{it} is equal to 1 if respondents intend to frequently use the car after 31DAYS/frequently used the car before 31DAYS, while $use_{it} = 0$ if they do not intend to frequently use the car after 31DAYS/did not frequently use the car before 31DAYS. The ATE is the average difference between the percentage of respondents who intend to frequently use the car (“More than once a week”) after 31DAYS and the percentage of respondents who frequently used the car (“More than once a week”) before 31DAYS. Namely, the ATE is the probability of a decrease in the intention to frequently use the car. For all coefficient estimates, we looked for statistical significance at the 5 % level and computed heteroskedasticity-robust standard errors.

Table 4 summarises the hypotheses which guided our analyses. We hypothesised that after the 31DAYS trial respondents intended to use the car less, and the e-bike, public transport, and car-sharing more. For car, e-bike and public transport use, we expected that 31DAYS managed to at least impact frequent car use along the week, reducing the percentage of households that intend to use the car “More than once a week”, and, correspondingly, increasing the percentage of households that reported intention to frequent e-bike and public transport use. Instead, our expectation was that variations in the intention to use the car, the e-bike and public transport around “Once a month or more” were less likely to occur, as they would respectively imply an increase in the percentage of households that use the car less than once per month and use the e-bike and public transport more than once per month—which is a frequency that is very close to “Never”. For car-sharing, we only expected to find an increase in the “Once a month or more” frequency, as by definition car-sharing is conceived as a sporadic service addressing unsystematic mobility needs.

3.4. Research question RQ2: effect on car ownership

To address Research Question RQ2 about car ownership, we compared the number of owned vehicles per household and owned travelcards per participant between $T0$ and $T1$, collected by the following questions:

- How many cars (e-bikes) are in possession of your household? (Zero, One, Two, Three, Four or more);
- What public transport pass(es) do you have? (None, Half-Fare, Zone subscription, Half-Fare and Zone subscription, Country pass).

Table 4
The hypotheses we performed regarding our research questions (RQ).

Research question	Hypothesis	Description
RQ1 Is 31DAYS effective in decreasing car use intention?	H1a	After 31DAYS, respondents intend to use the car less than they did before 31DAYS.
	H1a_Phase	*Respondents in early phases of change have greater intention to reduce car use than respondents in late phases of change.*
	H1b	After 31DAYS, respondents intend to use the e-bike more than they did before 31DAYS.
	H1b_Phase	*Respondents in early phases of change have greater intention to increase e-bike use than respondents in late phases of change.*
	H1b_Cohort	*The intention to use e-bike does not different between respondents allocated to different cohorts.*
	H1c	After 31DAYS, respondents intend to use the train more than they did before 31DAYS.
	H1c_Phase	*Respondents in early phases of change have greater intention to increase train use than respondents in late phases of change.*
	H1d	After 31DAYS, respondents intend to use bus and tram more than they did before 31DAYS.
	H1d_Phase	*Respondents in early phases of change have greater intention to increase bus and tram use than respondents in late phases of change.*
	H1e	After 31DAYS, respondents intend to use car-sharing more than they did before 31DAYS.
	H1e_Phase	*Respondents in early phases of change have greater intention to increase car-sharing use than respondents in late phases of change.*
RQ2 Is 31DAYS effective in decreasing car ownership?	H2a	After 31DAYS, the number of cars owned by the respondents' households decreases compared to before 31DAYS.
	H2a_Phase	*Respondents in late phases of change own less cars per household than respondents in early phases of change.*
	H2b	After 31DAYS, the number of e-bikes owned by the respondents' households increases compared to before 31DAYS.
	H2b_Phase	*Respondents in late phases of change have more e-bikes per household than respondents in early phases of change.*
	H2c	After 31DAYS, the number of public transport travelcards owned by the respondents increases compared to before 31DAYS.
	H2c_Phase	*Respondents in late phases of change have more public transport travelcards than respondents in early phases of change.*

The "Zone subscription" is a travelcard allowing to freely use public transport across the region of Winterthur and Zurich; the "Half-Fare" is a special Swiss travelcard allowing its holders to pay half of the price for any public transport route across the entire country, urban areas included; the "Country pass" is a full coverage travelcard for any public transport route across the country. The "Zone" travelcard targets habitual local public transport users, while the "Country pass", much less common as it costs about 4000 Swiss Francs/Euros per year, targets long-distance travellers across Switzerland. The "Half-Fare", instead, targets occasional users of public transport.

To address RQ2 we thus verified whether 31DAYS resulted in the decrease of car ownership and in the increase of e-bike and public transport travelcard ownership. We again adopted linear probability models like those of Eq. (1) where we used the number of cars and e-bikes owned in the household (Zero, One, Two, Three) and the number and type of travelcards owned by the respondent (None, Half-Fare, Zone, Half-Fare + Zone, Country pass), as the dependent binary variable ($ownership_{it}$). The average treatment effects (ATEs), again corresponding to the β_1 coefficients, represent the average changes, between T0 and T1, in the percentage of respondents whose household owns Zero, One, Two, Three cars/e-bikes, or who own each travelcard type. Since, by definition, before 31DAYS all households were at least owning one car, the ATE computed for the "Zero cars per household" binary dependent variable represents the effect of becoming car-free, namely the percentage of households that became car-free after participating in 31DAYS.

The hypotheses we tested are reported in Table 4: we expected that after 31DAYS more respondents' households owned less cars and more e-bikes. Also, that more respondents owned high-coverage travelcards, particularly the combination of Half-Fare and Zone travelcards.

3.5. Heterogeneity analyses

Besides estimating the effect of 31DAYS on the whole sample of respondents, we also analysed if and how the effect changed on varying the respondents' characteristics. Particularly, we aimed at verifying if the effect of 31DAYS was moderated by respondents' position along the transition process from "car dependency" to "car freedom". For this purpose, we referred to the Model of Action Phases (MAP, Gollwitzer, 1990; Bamberg, 2013b), which conceptualises the cognitive-motivational processes underlying a person's behaviour change as a progression between four phases: pre-decision, pre-action, action, and post-action. In the pre-decision phase the person has no intention to take action in the foreseeable future. When the awareness that a change may be needed arises, the person enters the pre-action phase, during which the intention to take specific actions in the immediate future is formed. When the person starts acting, the action phase is entered. The process is not concluded yet, however, as a post-action maintenance phase takes place, during which the person keeps performing the new behaviour and prevents possible relapse back to the previous phases. Specific socio-psychological factors (e.g. attitudes, personal norms, or social norms) can be acted upon to support progress between the phases (Ohnmacht et al., 2017).

We used the MAP model to classify respondents at $T0$ along the behaviour change process, from pre-decision ("car dependency") to post-action ("car freedom"), by relying on items already validated by Bamberg (2013a) (see Table 5). We then focused on a lower-granularity distinction between those who already act to reduce their car use and those who don't act, and re-coded participants in the two categories of the "early" and "late" phases.

We estimated the effect of 31DAYS on car use (RQ1) in the sub-groups of respondents in the early and late phases of change, by using linear probability models that compare past transport mode use with future behaviour intention. To do so, a term that represents the respondent's sub-group (Early or Late phases of change) was added to the model together with an interaction term

Table 5
The survey item we used at $T0$ to classify respondents based on their phase of change, and the corresponding re-coded variable representing the phase of change.

Phase	Answer item (Bamberg, 2013a)	Re-coded phase
Pre-decision	I currently use the car for most of my trips. I am happy with my current car use and see no reason to reduce it. I currently still use the car for most of my trips. I would like to reduce my current car use, but, at the moment, I feel it impossible to do so.	Early phases
Pre-action	I currently use the car for most of my trips. I am considering shifting some or all of these trips to modes other than cars, but I am not yet sure how I can replace these car trips and when I should do so.	Early phases
Action	I currently use the car for most of my trips, but my goal is to reduce my current car use. I already know which trips to replace and which alternative means of transport to use , but I have not put this into action yet.	Late phases
Post-action	Being aware of the many problems associated with car use, I already try to use other means of transport as much as possible. In the next few months, I will maintain or even reduce my already low car use. I already do not own or have access to a car, thus reducing my level of car use is not an issue at the moment.	Late phases

that represents the difference in the effect between the reference sub-group (for instance, respondents in Late phases of change) and the other sub-group (variable $post_{it} \times phase_i$), as shown in Eq. (2):

$$use_{it} = \beta_0 + \beta_1 post_{it} + \beta_2 phase_i + \beta_3 post_{it} \times phase_i + c_i + \epsilon_{it} \tag{2}$$

The conditional average treatment effect (CATE), namely possible differences between the sub-groups of respondents depending on their early or late phase of change, corresponds to the estimate of the β_3 coefficient attached to the interaction term.

We hypothesised that respondents in early phases of changes would result in greater intention to reduce car use, compared to past behaviour, than respondents in later phases of change. This is because, starting from a $T0$ condition in which a higher proportion of them was largely dependent on car use, this group had more room for change and may be more receptive to the 31DAYS intervention. Similarly, we hypothesised that respondents in early phases of change would result in greater intention to increase e-bike, train, bus and tram, and car-sharing use compared to past behaviour, than respondents in later phases of change (Table 4).

We used the same linear probability models to verify the lack of differential effects on e-bike use on varying the cohort—which, if present, would indicate the presence of seasonal effects around e-bike use and would suggest not to pool participants to the four cohorts into a single analysis. For this purpose, we used the same model as Eq. (2), in which we introduced a term representing the user's cohort, and an interaction term representing the difference in the effect between the reference cohort (e.g. cohort 1) and the other cohorts. The related hypothesis *H1b_Cohort* is reported in Table 4.

The same heterogeneity analyses were also replicated for car ownership (RQ2), again using Eq. (2), with an interaction term to distinguish between respondents in early and late phases of change. In this case, we used the binary $ownership_{it}$ dependent variable to represent the number of cars/e-bikes owned in the household, or the public transport travelcards owned by the respondent.

We hypothesised that respondents in late phases of changes decreased the number of cars owned by the household and increased the number of owned e-bikes and coverage of public transport travelcards, more than respondents in early phases of changes (Table 4). Buying a means of transport in fact requires financial investments, while selling it might cause perceived disadvantages. Therefore, we assumed these decisions to require higher maturity in the transition process. The same holds, even though to a less extent, to the decision to buy a public transport travelcard: as it implies frequent public transport use, we expected it took place among individuals already in late transition phases.

3.6. *Focus group analyses*

Focus groups were designed to investigate the same topics as the survey, to enrich findings from the latter with nuanced understandings on the phenomena and the reasons behind them, and also to ensure triangulation of the survey results and provide more evidence either supporting or confuting its findings. The focus group guideline was therefore on purposed highly overlapping with the survey questions.

All adult 31DAYS participants were invited to join the focus groups, by registering through a digital tool allowing to select suitable dates and times. No restrictions were made on the resulting sample of self-selected focus group participants, and no additional incentives for participation were offered either. With the participants' consent, audio recordings of the focus group discussions were made, and full transcripts were then created, by ensuring all collected data was pseudonymised.

The transcripts were then subjected to qualitative content analysis using the MAXQDA software tool. Initially, the individual items were analysed in isolation, and subsequently changes between the items between $T0$ and $T1$ were identified. For participants who attended both the initial and final focus group discussions, customer journeys were created to collect in-depth insight on changes at the individual level.

4. Results

Table 6 shows the number of survey respondents and focus group participants, compared to the number of adult participants to the four 31DAYS-Winterthur cohorts ($N = 754$). For our quantitative analyses, we only consider participants who responded to both $T0$ and $T1$ surveys: our analytical sample is made of $n = 257$ respondents, which corresponds to a 34 % response rate. Qualitative

Table 6
The number of 31DAYS adult participants (n), of survey respondents (quantitative analyses), and of focus group participants (qualitative analyses).

Period	Cohort	n	Quantitative analyses				Qualitative analyses		
			Only $T0$	Only $T1$	$T0$ and $T1$	Response rate [%]	Only $T0$	Only $T1$	$T0$ and $T1$
April–May 2024	1	222	23	5	26	11.7	4	5	14
May–June 2024	2	178	25	10	88	49.4	1	6	5
June–July 2024	3	160	19	14	67	41.9	2	—	1
July–August 2024	4	194	15	18	76	39.2	—	2	3
—	—	754	82	47	257	34.1	7	13	23

findings are instead based on data collected from overall $n = 43$ participants to either focus group at $T0$ or $T1$, or both ($n = 23$). Here we present the results of our quantitative analyses on the analytical sample, by enriching them with findings from the focus groups. The Supplementary materials (Section S1) also report graphical representations of the quantitative model results.

4.1. Characteristics of the analytical sample

The analytical sample is made of self-selected individuals, who voluntary decided to join 31DAYS and to answer the surveys, as there were no obligations to complete them. To evaluate its representativeness, we compare its characteristics with the Winterthur population, by using the 2021 sample of the Swiss Mobility and Transport Microcensus (MTMC, BFS/ARE, 2023), which is the most detailed and recent nation-wide survey regarding mobility behaviour in Switzerland (Table 7).

Compared to MTMC, a weighted probabilistic sample that is representative of the population of the Winterthur agglomeration, the 31DAYS analytical sample over-represents people in central stage of life, with a tertiary education degree. Low-income households and people living alone are instead under-represented. The 31DAYS sample also appears to be different from the population regarding ownership of transport modes at $T0$: there is a prevalence of single-car households, owning a higher number of bikes and e-bikes than the population.

Table 8 shows the mobility behaviour and ownership of public transport travelcards of the 31DAYS sample at $T0$: 48.0 % of the sample use the car “Several times a week” or “Everyday”, the rest uses it once a week or even less. Correspondingly, many sample members are used to frequent public transport use —though only 12.4 % of them owns a public transport travelcard that is typically associated with frequent and systematic public transport use (“Zone” and “Whole country” travelcards). Also, 21.8 % of the sample frequently uses the e-bike (“Several times a week” or “Everyday”).

We also verify the sample composition regarding the phase at $T0$ along the process from “car dependency” to “car freedom”. Coherently with their mobility behaviour and transport mode ownership, the answers by the 31DAYS respondents indicate that, even before the start of 31DAYS, more than half of the sample (57 %) already has a limited car use, suggesting they are already into the post-action phase of the transition to car freedom. Additionally, 17 % of the sample seems to be in the action phase. This implies that, at $T0$, 75 % of the analytical sample is in the late phases of change.

4.2. Research question RQ1: effect on car use intention

By running the models of Eq. (1) for all transport modes and the two frequencies of use “Once a month or more” and “More than once a week”, we obtain the model outputs summarised in Table 9.

Model results show statistically significant reductions in the intention to both use the car “More than once a week” and “Once a month or more”, compared to the behaviour before 31DAYS. The effect is higher for frequent use along the week: compared to its use before 31DAYS, the intention to use the car “Once a month or more” decreases in 11 % of the sample (ATE = −0.113), while the intention to use it “More than once a week” decreases in 36 % of the sample (ATE = -0.362). The model outputs thus suggest to accept Hypothesis $H1a$: participation in 31DAYS leads to a tangible reduction in the intention to use the car.

Insights from the focus groups suggest that such a reduction took place for both systematic and non-systematic trips:

- *I used to take the car for short distances, so a lot has changed for me. When I take the children to the daycare center in the morning, I used to do it quickly in two minutes by car. I won’t do that again.*
- *In the past, if I forgot something in the city, I took the car for the second trip. When it rained, it was also the car, now I’m putting on my rain pants and use the bicycle.*

Overall, focus group participants confirmed that 31DAYS lead them to critically rethink their car use and to recognise where in their daily life they could forgo car use, thus developing new mobility behaviour.

By considering sample sub-groups based on their phase of change from “car dependency” to “car freedom”, we find a 54 % decrease in the share of early-phase respondents reporting they intend to use car “More than once a week”, compared to previous behaviour. Among late-phase respondents, we also find a significant decrease, which however only affects 30 % of the participants (ATE = −0.298). As shown by the CATE, equal to -0.230, these percentages are significantly different at the 5 % level. Thus, we also accept Hypothesis $H1a\_Phase$: respondents in early phases of change have greater intention to reduce car use than those in late

Table 7
Comparison of the 31DAYS analytical sample at $T0$ with the Winterthur agglomeration population (2021, Swiss Mobility and Transport Micro-Census), via *t*-tests.

Characteristics		31DAYS		MCMT		Δ	*p*-value
		n	[%]	n	[%]	[%]	
Gender	Female	137	53.3	395	48.3	5.0	0.179
	Male	115	44.7	423	51.7	−6.9*	0.061
	Other	1	0.4	0	0.0	0.4	0.317
	Missing	4	1.6	0	0.0	1.6**	0.044
Age group	18–29 years old	28	11.0	141	17.2	−6.2**	0.016
	30–39 years old	74	28.8	160	19.6	9.2***	0.006
	40–49 years old	57	22.2	137	16.7	5.5*	0.068
	50–59 years old	34	13.2	131	16.0	−2.8	0.268
	60–69 years old	43	16.7	98	12.0	4.8*	0.066
	70+ years old	19	7.4	152	18.6	−11.2***	< 0.001
	Missing	2	0.8	0	0.0	0.8	0.156
Education	Compulsory education	7	2.7	95	11.7	−8.9***	< 0.001
	Vocational school	74	28.8	280	34.2	−5.4	0.112
	High school	22	8.6	181	22.1	−13.5***	< 0.001
	University	154	59.9	257	31.5	28.5***	< 0.001
	Missing	0	0.0	5	0.6	−0.6*	0.053
Gross household monthly income	Up to 6000 CHF	47	18.3	236	28.8	−10.5***	0.001
	6000–12,000 CHF	137	53.3	305	37.3	16.0***	< 0.001
	More than 12,000 CHF	44	17.1	159	19.4	−2.3	0.414
	Missing	29	11.3	118	14.4	−3.2	0.191
Household composition	Has 0–12 year children	62	24.1	161	19.6	4.5	0.154
	Has no 0–12 year children	195	75.9	657	80.4	−4.5	0.154
	Lives alone	36	86.0	626	76.7	9.4***	0.001
	Does not live alone	221	14.0	192	23.4	−9.4***	0.001
Cars in the household	0	0	0.0	236	28.9	−28.9***	< 0.001
	1	225	87.5	386	47.2	40.3***	< 0.001
	2	31	12.1	157	19.2	−7.1***	0.005
	3 or more	1	0.4	35	4.33	−3.9***	< 0.001
	Missing	0	0.0	4	0.4	−0.4	0.136
Bikes in the household	0	29	11.3	187	22.9	−11.6***	< 0.001
	1	47	18.3	155	19.0	−0.7	0.804
	2	63	24.5	185	22.7	1.9	0.558
	3 or more	118	45.9	286	35.0	10.9***	0.003
	Missing	0	0.0	4	0.55	−0.5	0.164
E-bikes in the household	0	147	57.2	621	75.9	−18.7***	< 0.001
	1	71	27.6	125	15.3	12.3***	< 0.001
	2	35	13.6	57	7.0	6.7***	0.004
	3 or more	4	1.6	13	1.6	−0.1	0.933
	Missing	0	0.0	2	0.2	−0.82	0.317

* *p*-value ≤ 0.10; ** *p*-value ≤ 0.05; *** *p*-value ≤ 0.01.

phases of change. Insights from focus groups confirm that, comparing frequent car users and people who use the car less frequently, the latter tended to make smaller changes to their behaviour.

Coherently with the decrease in the intention to use the car, model outputs show statistically significant increases in the intention to use the e-bike, compared to previous behaviour: we find an 8 % increase in the share of those intending to use the e-bike at least once a month, and a 10 % increase in the share of those intending to use the e-bike more than once a week. We thus accept Hypothesis $H1b$: participation in 31DAYS leads to a tangible increase in the share of respondents intending to use the e-bike. The heterogeneity analyses, instead, show no statistically significant differences in e-bike use intention between respondents in early and late phases of change: no CATE estimate is significant, thus we reject Hypothesis $H1b\_Phase$.

Regarding e-bikes, we expected that during the Spring-Summer season during which 31DAYS took place, their use was not differentially affected by varying the cohort of the participants (*H1b_Cohort*)—this was in fact the reason why we pooled data from all cohorts, and analysed them as a whole. Model results are reported in the Supplementary Material (Section S2): they indicate that no statistical differences among cohort members exist in the effect on e-bike use, which confirms our expectation of no seasonal effects among the cohorts, and our choice to analyse together all cohort data.

Indeed, focus group participants reported about the pleasure of riding an e-bike, even in bad weather: *I've been travelling by e-bike for the last four weeks in my everyday life, because it was fun and it's easier to get from one place to another. And I miss the e-bike. I'm thinking to buy one myself.*

Table 8
Descriptive characteristics of the 31DAYS sample at $T0$ regarding mobility behaviour, public transport travelcard ownership, and behaviour change phase.

Characteristics	Original variable	n	[%]	Recoded variable	n	[%]
Car use	Never	4	1.6			
	Less than once a week	50	19.4	Once a month or more	253	98.40
	Once a week	77	30.0			
	Several times a week	107	41.6	More than once a week	126	49.0
	Everyday	19	7.4			
E-bike use	Never	175	68.1			
	Less than once a week	9	3.5	Once a month or more	82	31.90
	Once a week	17	6.6			
	Several times a week	29	11.3	More than once a week	56	21.80
	Everyday	27	10.5			
Train use	Never	19	6.2			
	Less than once a week	91	35.4	Once a month or more	241	93.80
	Once a week	66	25.7			
	Several times a week	69	26.9	More than once a week	84	32.70
	Everyday	15	5.8			
Bus and tram use	Never	23	8.9			
	Less than once a week	71	27.6	Once a month or more	234	91.00
	Once a week	65	25.3			
	Several times a week	83	32.3	More than once a week	98	38.10
	Everyday	15	5.8			
Car-sharing use	Never	254	98.8			
	Less than once a week	3	1.2	Once a month or more	3	1.20
	Once a week	0	0.0			
	Several times a week	0	0.0	More than once a week	0	0.00
	Everyday	0	0.0			
Public transport travelcard	None	31	12.1	–	–	–
	Half-Fare	179	69.0	–	–	–
	Zone	16	6.2	–	–	–
	Half-Fare and Zone	10	3.9	–	–	–
	Whole country	6	2.3	–	–	–
	Missing	15	5.8	–	–	–
Behaviour change phase	Pre-decision phase	32	12.4	Early phase	69	26.85
	Pre-action phase	37	14.4			
	Action phase	44	17.1	Late phase	188	73.15
	Post-action phase	144	56.0			

Table 9
The effect of participation in 31DAYS on future use (intention) compared to past use (behaviour), per transport mode, use frequency, and sample. Heteroskedasticity-robust standard errors SE are reported in brackets.

Transport mode use,		Once a month or more				More than once a week			
Sample and Hypothesis		ATE (SE)	*p*-value	CATE (SE)	*p*-value	ATE (SE)	*p*-value	CATE (SE)	*p*-value
Car H1a	Whole sample	−0.113*** (0.022)	< 0.001	—	—	−0.362*** (0.038)	< 0.001	—	—
	Early phases	−0.087** (0.034)	0.011	0.035 (0.044)	0.421	−0.536*** (0.071)	< 0.001	−0.230*** (0.083)	0.004
	Late phases (ref.)	−0.122***(0.028)	< 0.001	—	—	−0.298*** (0.041)	< 0.001	—	—
E-bike H1b	Whole sample	0.078* (0.042)	0.066	—	—	0.105*** (0.039)	0.007	—	—
	Early phases	0.043 (0.078)	0.557	−0.047 (0.092)	0.613	0.087 (0.070)	0.215	−0.025 (0.084)	0.768
	Late phases (ref.)	0.090* (0.050)	0.071	—	—	0.112** (0.046)	0.017	—	—
Train H1c	Whole sample	−0.019 (0.023)	0.394	—	—	0.105** (0.043)	0.014	—	—
	Early phases	0.014 (0.049)	0.772	0.046 (0.055)	0.407	0.130* (0.076)	0.087	0.035 (0.091)	0.704
	Late phases (ref.)	−0.032 (0.025)	0.207	—	—	0.096* (0.050)	0.059	—	—
	Whole sample	0.027 (0.023)	0.244	—	—	0.136*** (0.044)	0.002	—	—
Bus and Tram H1e	Early phases	0.043 (0.042)	0.301	0.022 (0.050)	0.660	0.217*** (0.081)	0.007	0.111 (0.095)	0.247
	Late phases (ref.)	0.021 (0.028)	0.448	—	—	0.106* (0.051)	0.039	—	—
	Whole sample	0.047*** (0.016)	0.004	—	—	0.000 (NaN)	NaN	—	—
Car-sharing H1e	Early phases	0.058* (0.031)	0.063	0.015 (0.039)	0.692	0.000 (NaN)	NaN	0.000 (NaN)	NaN
	Late phases (ref.)	0.043** (0.018)	0.019	—	—	0.000 (NaN)	NaN	—	—

* p-value ≤ 0.10; ** p-value ≤ 0.05; *** p-value ≤ 0.01.

Table 10
The effect of participation in 31DAYS on household vehicle ownership, per vehicle type, number of vehicles per household, and sample. Heteroskedasticity-robust standard errors SE are reported in brackets.

Owned vehicle, Hypothesis, Sample		Zero vehicles per household				One vehicle per household			
		ATE (SE)	*p*-value	CATE (SE)	*p*-value	ATE (SE)	*p*-value	CATE (SE)	*p*-value
Car H2a	Whole sample	0.023** (0.009)	0.013	—	—	−0.004 (0.029)	0.895	—	—
	Early phases	0.029 (0.020)	0.153	−0.008 (0.028)	0.736	−0.014 (0.063)	0.820	0.014 (0.072)	0.839
	Late phases (ref.)	0.021** (0.010)	0.045	—	—	< 0.001 (0.037)	1.000	—	—
E-bike H2b	Whole sample	−0.031 (0.043)	0.479	—	—	0.011 (0.046)	0.732	—	—
	Early phases	−0.029 (0.082)	0.726	−0.016 (0.098)	0.976	< 0.001 (0.077)	1.000	−0.016 (0.090)	0.859
	Late phases (ref.)	−0.031 (0.052)	0.536	—	—	0.016 (0.047)	0.732	—	—

Owned vehicle, Hypothesis, Sample		Two vehicles per household				Three vehicles per household			
		ATE (SE)	*p*-value	CATE (SE)	*p*-value	ATE (SE)	*p*-value	CATE (SE)	*p*-value
Car H2a	Whole sample	−0.019 (0.028)	0.483	—	—	< 0.001 < 0.001	1.000	—	—
	Early phases	−0.014 (0.058)	0.805	0.007 (0.067)	0.919	< 0.001 < 0.001	1.000	< 0.001 < 0.001	1.000
	Late phases (ref.)	−0.021 (0.031)	0.495	—	—	< 0.001 < 0.001	1.000	—	—
E-bike H2b	Whole sample	0.019 (0.028)	0.533	—	—	< 0.001 < 0.001	1.000	—	—
	Early phases	0.028 (0.052)	0.574	0.013 (0.064)	0.839	< 0.001 < 0.001	1.000	< 0.001 < 0.001	1.000
	Late phases (ref.)	0.016 (0.038)	0.676	—	—	< 0.001 < 0.001	1.000	—	—

* p-value ≤ 0.10; ** p-value ≤ 0.05; *** p-value ≤ 0.01.

Similar results emerge for use of public transport: model outputs respectively indicate an 11 % and a 14 % increase in the share of respondents intending to use the train, and tram and bus, more than once a week. Therefore, we also accept Hypotheses $H1c$ and $H1d$: participation in 31DAYS leads to a tangible increase in the intention to use trains, trams, and buses. Instead, although the trends suggest a greater increase in the intention to use trains, buses, and trams more than once a week among participants in the early phases of change, the differences between the early and late phases sub-groups quantified by the CATE estimates are not statistically significant. We thus reject Hypotheses $H1c\_Phase$ and $H1d\_Phase$.

Finally, we consider car-sharing. The intention to at least sporadically (“Once a month or more”) use it significantly increases by 5 % in the sample. We thus accept Hypothesis $H1e$: participation in 31DAYS tangibly increases the intention to use car-sharing services. Neither relevant trends nor statistically significant differences instead appear between sub-groups of respondents by phase of change, thus we reject Hypothesis $H1e\_Phase$. Focus group discussions indicate that car-sharing would support non-systematic, specific mobility needs for which a car would still suit the most:

- *My wife says we don’t need the car anymore. There are so many cars in our neighbourhood: if we have an emergency, we can borrow one;*
- *I have a large compost delivery in the garden. We used the car for that. That’s about 200 liters each. That would be something I could also use car-sharing for.*

4.3. Research question RQ2: effect on car ownership

Our model outputs, reported in Table 10, suggest a statistically significant increase in the zero-car households, equal to 2.3 % of the sample. Model outputs also suggest a decrease in the share of households owning one or two cars, though such trends lack statistical significance. Such a tendency to decrease car ownership, even though not becoming a “car-free household” yet, also emerges from the focus group discussions: some of the participants stated that the 31DAYS experience helped them to convince their partners or family members to sell their car. Model outputs also suggest no heterogeneous effects between sub-group of respondents in early or late phases of change, as the CATE estimates are never statistically significant. We thus accept Hypothesis $H2a$ but reject Hypothesis $H2a\_Phase$.

We also test hypothesis $H2b$ on e-bike ownership. Model outputs indicate non statistically significant changes in the percentage of households respectively owning one, two, three e-bikes, or no e-bike at all. Therefore, we reject $H2b$: despite the trends, there is no evidence of an increase in e-bike ownership. Similarly, the heterogeneity analyses on respondents based on their phase of change suggest there are no statistically significant differences in e-bike ownership between the early and late phase respondents. Therefore, we also reject hypothesis $H2b\_Phases$.

Finally, we estimate the effect on individual ownership of public transport travelcards. For this analysis we can only rely on a sample of $n = 242$ respondents, as for $n = 15$ of the individuals included in our analytical sample the $T0$ information on travelcards, directly collected by the 31DAYS initiators via the 31DAYS registration form, was missing. By comparing the information collected at $T0$ and $T1$, we find no statistically significant changes in the sample share with no public transport travelcards (Table 11).

However, we find a 4 % decrease in the share of those who only own the Zone travelcard, accompanied by a 9 % increase in the share of those who own both the Zone and the Half-Fare travelcard. These results suggest that 9 % of the sample started to opt for public transport for both their systematic trips (covered by the Zone travelcard) and their casual trips (covered by the

Table 11
The effect of participation in 31DAYS on individual ownership of public transport travelcards, per travelcard type and sample. Heteroskedasticity-robust standard errors SE are reported in brackets. *Note*: here the sample size is $n = 242$.

Owned travelcard,		No travelcard				Half-Fare travelcard			
Hypothesis, Sample		ATE (SE)	*p*-value	CATE (SE)	*p*-value	ATE (SE)	*p*-value	CATE (SE)	*p*-value
Public transport H2c	Whole sample	−0.004 (0.030)	0.891	—	—	−0.050 (0.041)	0.228	—	—
	Early phases	0.015 (0.077)	0.844	0.026 (0.082)	0.747	< 0.001 (0.080)	1.000	0.068 (0.096)	0.478
	Late phases (ref.)	−0.011 (0.0030)	0.746	—	—	−0.068 (0.047)	0.157	—	—
Owned travelcard,		**Zone travelcard**				**Half-Fare + Zone travelcards**			
Hypothesis, Sample		**ATE (SE)**	***p*-value**	**CATE (SE)**	***p*-value**	**ATE (SE)**	***p*-value**	**CATE (SE)**	***p*-value**
Public transport H2c	Whole sample	−0.041** (0.018)	0.029	—	—	0.091*** (0.025)	< 0.001	—	—
	Early phases	−0.030** (0.028)	0.032	0.015 (0.037)	0.670	0.015 (0.035)	0.560	−0.104** (0.042)	0.014
	Late phases (ref.)	−0.045* (0.023)	0.053	—	—	0.119*** (0.032)	< 0.001	—	—
Owned travelcard,		**Whole country travelcard**							
Hypothesis, Sample		**ATE (SE)**	***p*-value**	**CATE (SE)**	***p*-value**				
Public transport H2c	Whole sample	0.004 (0.014)	0.779	—	—				
	Early phases	< 0.001 (0.028)	1.000	−0.005 (0.039)	0.885				
	Late phases (ref.)	0.005 (0.014)	0.703	—	—				

* *p*-value ≤ 0.10; ** *p*-value ≤ 0.05; *** *p*-value ≤ 0.01.

Half-Fare travelcard). We thus accept Hypothesis $H2c$. Insights from focus group discussions suggest that the key reasons for not buying additional travelcards was because they were not perceived as financially worthwhile.

Model outputs also suggest that the increase in the share of owners of both Zone and Half-Fare travelcards is mostly due to respondents in the late phases of change. In fact, the differences between the sub-groups are significant at the 5 % level. We thus also accept Hypothesis $H2c\_Phase$.

5. Discussion

Our findings on the Winterthur 31DAYS Challenge confirm results already obtained by many authors (e.g., Laakso, 2017; van Vessem et al., 2024; Abou-Zeid and Ben-Akiva, 2012, or Beale and Bonsall, 2007), about the tendency of car-free and public transport trials to mostly appeal to individuals who are already inclined to reducing car use, and who differ in their socio-demographic characteristics from the average population. As reported in Table 8 (see the last rows on the phases of change according to the Model of Action Phases), most of the respondents in fact reported that, before 31DAYS, they were already into late phases of the process of change from “car dependency” to “car freedom”.

Specifically regarding our research questions and hypotheses, our results suggest that 31DAYS was effective in reducing the intention to use the car (RQ1)—and particularly in reducing frequent car use along the week— and consequently in promoting the increase in the intention to use e-bikes, public transport, and even car-sharing. This result applies both to systematic and non-systematic trips for which cars would still suit the most, as suggested by the results of our focus groups. Furthermore, we found that a larger share of respondents in early phases (54 %) intends to reduce using car “More than once a week” than the share of respondents in late phases of change (30 %). This suggests that the average reduction effect in the intention to use the car we found across the whole sample (ATE equal to 36 % of respondents) is mostly driven by the respondents in early phases. This is coherent with our $H1a\_Phase$ hypothesis, namely that 31DAYS is more effective in the early phase sub-group of respondents, given that a larger percentage of them uses the car very often at $T0$ compared to the late phase group, and therefore has more room to reduce car use.

The early phase participants are also those that were mostly in need of change, as they are closer to the “car dependency” situation. Indeed, they correspond to the actual 31DAYS participant target. Our results therefore suggest that, if 31DAYS had managed to raise more interest by those early phase individuals that, according to the MCMT sample, are closer to the average Winterthur population, its effect would have been even larger, up to 54 %. In other words, the 36 % average treatment effect we have estimated for the reduction in car use intention is most likely an under-estimate of the actual potential of 31DAYS. Hence, to fully achieve its potential for change, 31DAYS or similar initiatives should aim at engaging the proper target participants, rather than “preaching to the converted”, already ahead in the transition process. In practical terms, however, how to actually raise their interest and engage them would remain an open challenge.

In any case, despite the promising effect on many participants’ intention to reduce car use and increase use of alternative transport modes, immediately after its end the Winterthur 31DAYS Challenge did not drive large-scale radical effects regarding car ownership (RQ2): we did find an effect on car ownership, however only just over 2 % of the participants became a “car free household”. Furthermore, despite the increase in the intention to use an e-bike, participants did not buy new e-bike(s) for their household. And, despite the increase in ownership of public transport travelcards (which is coherent with the increase in the intention to use train, bus, and tram), no complete substitution between car ownership and public transport use occurred either. Our findings thus suggest that public transport travelcards and car ownership are still perceived as complementary, rather than alternative, elements.

From an environmental perspective, this is a good start. Because with current fossil fuelled, combustion engine vehicles, it is the use phase which causes a relevant part of the emissions and particularly CO_2 emissions. Hence, any trip saved and done by public transport is a gain. However, with electric vehicles, in a country like Switzerland with relatively low CO_2 emissions per kWh electricity, it is the production phase which takes the highest toll in terms of CO_2 emissions (Cox et al., 2020). There, the complementarity is not an advantage: the CO_2 emissions from the production of the electric vehicle really represent a wasted burden.

Overall, we conclude that, in the infrastructural and material supportive context of Winterthur, the 31DAYS Challenge is aligned with previous trials: it produces partial substitution effects between car, e-bikes, public transport, and car-sharing, which in the very short-term are not sufficient to trigger a large-scale transition to radical car-free living conditions.

5.1. A longer-term perspective

Differently from buying a public transport travelcard, selling a car definitely requires time. Trying car alternatives for one month might be sufficient to mature the decision to sell a car; however, more time might be needed before such a decision turns into reality. This might be due to very practical reasons, such as finding buyers or understanding how to scrap it, if it is too old for new owners. It is therefore reasonable that, though they had matured the decision to sell (one of) their car(s), at $T1$ the participants had not yet sold it. Data collected by the 31DAYS initiators can help us to capture possible car selling results that were concluded after $T1$.

On October, 25 2025 we accessed the list of the $n = 80$ participants that were eligible for the 3000 CHF car selling incentive that was offered by the City of Winterthur, and then matched it with our $n = 257$ analytical sample. We found that, by two months from $T1$, 34 respondents, namely 13.23 % of the analytical sample, had sold a car. We also looked for possible car selling differential effects, but no differences emerged between early and late phase participants.

These elements may suggest that, by just increasing the time between the end of 31DAYS and the measurement of its effects, stronger effects about car ownership are found. However, it is very likely that the car selling decision was influenced by the generous monetary incentive by the City of Winterthur, particularly for those owning an old vehicle with low commercial value in the second-hand market. For this reason, we cannot use the 13 % data on car selling as a strict estimate of the 31DAYS effect. Future research involving challenges similar to 31DAYS is needed to assess the true car selling longer-term effect, free from spurious effects of initiatives such as the incentives, that —though connected— are not directly part of the challenge itself. Still, the additional data collected after $T1$ suggests that a larger car selling effect may have actually occurred, definitely calling for more research on the topic.

5.2. Limitations

Despite the care we devoted to ensuring strict data collection and analysis processes, our findings are affected by a number of methodological limitations. First of all, they only refer to the short-time effect of the Winterthur 31DAYS Challenge. Future research on similar challenges is needed to overcome our short-term perspective and fully assess the effect on car ownership.

Second, we compare past behaviours with intentions. Though widely used theories in the transport domain such as the Theory of Planned Behaviour (Ajzen, 1985) consider intention as the direct antecedent of behaviour, we lack evidence that 31DAYS participants' intentions will actually turn into behaviour. Longer-term analyses would also allow to verify if our results about mobility intention turn into actual behaviour and then survive the test of time, being maintained in the long-term.

Third, our analyses are grounded on respondents' self-reported data, therefore we cannot exclude our results are affected by social desirability phenomena at both $T0$ and $T1$, which would bias our estimates. The risk of desirability biases due to self-reported behaviour measurements has for instance been remarked by a systematic review by Cleland et al. (2023) aimed at identifying the most effective behavioural approaches to reduce car use.

Fourth, our quasi-experimental design lacks a control group, which implies the changes we observe between $T0$ and $T1$ cannot be causally and univocally attributed to 31DAYS. Indeed, systematic reviews and meta-analyses by Arnott et al. (2014), Graham-Rowe et al. (2011), and Möser and Bamberg (2008) identified the lack of experimental research designs (namely of control groups and random assignment to treatment and control) among the most critical factors questioning the evidence of effectiveness by early interventions. In fact, even though to our knowledge they have not been implemented, we cannot exclude that the effects we report in Table 9 are due to new radical measures by the City of Winterthur on urban mobility, such as strict regulations on car speed or access, or mobility and parking pricing.

And fifth, the lack of representativeness of our analytic sample, which is due to both the self-selection underlying participation to 31DAYS and the self-selection due to the lack of constraints to answer the $T0$ and $T1$ surveys and join the focus groups, implies that our results are only valid for our analytic sample. However, among the self-selected participants we assume that survey respondents and focus group participants are not systematically different from survey non-respondents and focus group non-participants, as we did not offer specific incentives to answer the survey or join the focus groups. Even though we lack information on their socio-economic and psychological characteristics, and therefore cannot entirely exclude biases, we argue that our results can reasonably be representative of the Winterthur 31DAYS participants. Instead, caution is needed in generalising our results to the broader Winterthur population. No agglomeration-wide data is in fact available regarding the distribution of the Winterthur population along the "phases of change", but the SMTC data about mobility behaviour suggests they are well below the 75 % of people in late phases of change characterising the 31DAYS analytical sample.

Ideally, future research aimed at estimating the effects of 31DAYS-like challenges should opt for randomised controlled trials performed over a random sample of the population, thus ensuring both internal and external validity. Even though more complex to design and implement than the one-group pretest-posttest scheme we used for the Winterthur 31DAYS Challenge, many scientifically sound experimental studies on soft policy interventions aimed at reducing car use have already been performed in the last three decades, as for instance documented in the meta-review by Semenescu et al. (2020).

A more thorough embedding of the research analyses accompanying the trial within the trial activities themselves would help to ensure higher response rates. For this purpose, research teams should even more strictly engage and liaise with the trial organisers and managers. Moreover, to ensure long-term analyses, future randomised controlled trials could be designed to automatically collect data via mobility tracking apps, for instance by adopting the approach suggested by Gerosa et al. (2025). Use of automatic tracking devices would allow to collect long historical data series that are exempt from the errors or biases that may affect self-reported data collection processes. Despite possible transport mode detection errors, the ease of collecting mobility data would facilitate access to richer data-sets of mobility behaviour over time, thus allowing more reliable estimates of interventions' long-term effects, possibly also accounting for seasonal effects that influence active mobility and e-bike use.

6. Conclusions

In this article we estimated the effects of the Winterthur 31DAYS Challenge: a trial performed in Spring-Summer 2024 in the Swiss city of Winterthur —a context very supportive of cycling and car alternatives— to reduce car use, favour multi-modal mobility, and ultimately promote car-free living. The Winterthur 31DAYS Challenge engaged 754 adult participants, that were provided with one month of free e-bike, public transport, and car-sharing subscriptions, and committed to use their car as little as possible.

We estimated the effect of the Winterthur 31DAYS Challenge on car use intention (research question RQ1) and car ownership (research question RQ2), via a survey-based pretest-posttest policy evaluation design ($n = 257$) enriched with in-person focus group discussions ($n = 43$). Our results are in line with evidence provided by previous research on car-free trials.

First, 31DAYS mostly attracted individuals who are already into the late phases of the transition towards car-free living. Second, in the short-term, 31DAYS managed to reduce the intention to frequently use the car "More than once a week" in 36 % of the participants, and —though with lower intensity— also to increase the intention to frequently use e-bikes, public transport, and even car-sharing. In the sub-group of participants in the early phases of the transition to car-free living, the effect was much higher, equal to 54 %. These results suggest the presence of substitution effects between cars and e-bikes, public transport, and car-sharing. Third, it also managed to reduce car ownership immediately after its end, with 2 % of the participants becoming car-free households. Two months later, also under the influence of generous incentives by the City of Winterthur, 13 % of the respondents had sold a car. These figures suggest that, in most of the participants, the substitution was partial, rather than complete.

Based on our short-term analyses, we thus conclude that, despite its very promising results on the intention to reduce car use and increase use of other transport modes, 31DAYS was limitedly effective in inducing fast and radical transitions leading to car-free living —even in the highly supportive material context of the City of Winterthur. Our short-term evidence strengthens the findings from recent mobility trials and suggests that, for a faster and larger-scale transition to post-car societies, policy-makers should combine trials with measures specifically aimed at discouraging car ownership and its use, and possibly also at incentivising car selling via monetary support. Financial incentives might in particular be useful to induce people in the advanced phases of the car selling decision-making process to finally opt for abandoning their car. Their cost, certainly relevant, might be competitive, compared to the huge investments needed to address the externalities produced by car use (Ecoplan/INFRAS, 2024), particularly at the light of the costs of adaptation to climate change.

Future research on longer-term effects is however needed to confirm or reject our short-term findings. Trials like the Winterthur 31DAYS Challenge are particularly well-suited for longitudinal panel analyses: accompanied by proper communication support and reminders, they might allow to reach satisfying response rates, also for survey waves that are distant in time from trial participation. If future analyses will confirm our current findings, research efforts will then need to focus on how to identify effective ways to raise the interest of individuals that could benefit the most from trial participation, namely those in the early transition phases towards car-free living.

CRediT authorship contribution statement

Francesca Cellina: Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization; **Tiziano Gerosa:** Writing – review & editing, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization; **Leonardo Ventimiglia:** Software, Formal analysis, Data curation; **Raphael Hoerler:** Writing – review & editing, Methodology, Investigation, Conceptualization; **Andrea Del Duce:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Conceptualization; **Nadine Klopfenstein Frei:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Conceptualization; **Julia Grundisch:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation.

Data availability

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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Supplementary material

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