# Appendix

Appendix Fig. A1: the meanings of numbers in columns “Type of interventions” and “Sub-type of interventions” can be found in Fig. A1.



**Fig. A1** Classification of sustainable travel behavior interventions.

**Table A1** Workplace intervention studies.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference | City, country (region) | Participant description | Type of experiment | Random sequence generation bias | Allocation concealment bias | Blinding of participants and personnel bias | Blinding of outcome assessment bias | Incomplete outcome data bias | Selective reporting bias | Other sources of bias | GRADE level | Number of participants (in each group) | Comparison group | Type of interventions | Sub-type of intervention | Measure | Outcome |
| Tørnblad et al., 2014 | Skedsmo, Norway | Employees of six companies within an area | Quasi-experiment | High | Unknown | High | Low | Low | Low | Low | Moderate | 506 (122, 255, 129) | With | 1, 6 | 1.1, 6.2 | Tailored travel information (information about buses operating in the area close to their workplace, a map showing the locations of bus stops near workplace, information about tickets and prices, advice on how to find information online and via smartphone applications, credit card sized bus schedules), and/or a free 7-day public transit pass. | No significant effect. |
| Thøgersen, 2009 | Copenhagen, Denmark | People who have a driver’s license and a car at their disposal, commute to job or study at least once a week, and not having been a monthly travel card holder for mass transit | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | High | 1071 (70%, 30%) | With | 1, 6 | 1.1, 6.2 | For those expressing an intention to commute by mass transit in the near future: (i) a planning exercise alone or (ii) a planning exercise plus a free month travel card; for those expressing no intention: (iii) a customized timetable alone, (iv) a customized timetable plus a free month travel card, or (v) a free month travel card alone. | Only free month travel card had effect in increasing mass transit travel. |
| Abou-Zeid and Ben-Akiva, 2012; Abou-Zeid and Fujii, 2016 | Massachusetts, USA | Employees of MIT with full-time parking permits | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 67 | Without | 6 | 6.2 | Free public transit pass (participants must commute to MIT by public transportation for 2–3 d in a week). | 30% of participants turned to bus travel, and the effect could last for a period of time. Dissatisfaction towards commuting by bus declines. |
| Castellanos, 2016 | Bogota, Colombia | Young adults (mainly university students and young professionals) | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 20 | Without | 1, 2, 4, 5 | 1.1, 2.1, 4.1, 5.1, 5.5 | Gamification incentives; points from commuting distance and modes; ranking and financial incentives according to points. | Travel pattern change existed but not significant; travel time and distance increased slightly. |
| de Kruijf et al., 2018 | North-Brabant, Netherlands | (1) Conducting at least 50% of their total weekly work trips by car before entering the program, (2) having a commute distance of at least 3km, and (3) being between 18 and 65 years old and working in the province | Experiment without control | High | High | High | High | Unknown | Low | High | Low | 547 | Without | 5 | 5.1, 5.5 | Direct financial incentives. | Travel proportion of e-bike increased to 68% after a month, maximum to 73% after half a year. |
| Olsson et al., 2021 | Värmland, Sweden | Staff from 10 companies and institutions the local hospitals, consultancy agencies (city planning, engineering, and innovation), municipality services, and departments | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | Moderate | 172 (44, 33, 95) | With | 3, 5 | 3.3, 3.4, 5.1 | (i) Financial incentive (a bike); (ii) moral norms (environment protection of biking); (iii) social norms (fun of biking). | None of three nudges had no significant effect, but all decreased usage of cars and increased biking. |
| Günther et al., 2020 | Chemnitz, Germany | (1) Have an active employment with Chemnitz University of Technology, (2) take part in the data collection, and (3) accept the legal conditions of use | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 108 | Without | 1, 2, 3, 4, 5 | 1.1, 2.1, 3.3, 4.1, 5.1 | Feedback regarding energy consumption, gamification, and financial rewards. | Gamification and financial rewards can decrease energy consumption. |
| Mutrie et al., 2002 | Glasgow, UK | Employees thinking about walking or cycling to work | Randomized controlled trials | Low | Unknown | High | Low | Low | Low | Low | Moderate | 166 (87, 79) | With | 1, 3, 6 | 1.1, 3.1, 6.2 | A booklet with written interactive materials, providing educational and practical information on choosing routes, maintaining personal safety, shower and safe cycle storage information, and useful contacts. The pack also included an activity diary in the form of a wall chart, a workplace map, distances from local stations, local cycle retailers and outdoor shops, contacts for relevant organizations, local maps, and reflective safety accessories. | The experimental group made twice as many trips to work on foot as the control group, but no significant effect by bike. |
| Brockman and Fox, 2011 | Bristol, UK | Staff of Bristol University | Multi experiment without control | High | High | High | High | Unknown | Low | High | Moderate | 2292, 2332, 1950, 2647, 2829 | Without | 5, 6 | 5.1, 6.1, 6.2, 6.3 | Heavily limiting parking spaces and conditions for permits, increased parking charges, improving changing facilities for walkers and cyclists, new secure cycle storage, a subsidized cycle purchase scheme, a car-sharing scheme, a free university bus service which served local train and bus stations, and discounted season tickets on buses. | Proportion of people commuting on foot increased by 19%-30% while that by bike increased by 7%-12% (except 2007) and that by car decreased by 33%-50%. |
| Wen et al., 2005 | Sydney, Australia | Health service employees | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 68 | Without | 1, 6 | 1.1, 6.2 | Specific campaign materials, such as posters and banners, fridge magnets transport access guide, e-mail newsletters, messages on payslips and flyers. | Proportion of employees commuting by active travel most increased from 37% to 45%; proportion of employees commuting by car 5 times in a week decreased by 20%. |
| O'Fallon, 2009 | Auckland, Wellington, Nelson, Blenheim, New Zealand | Employees | Experiment without control | High | High | High | High | Low | Low | High | Low | 1587 | Without | 1, 3, 6 | 1.1, 3.1, 6.1, 6.2 | Bike buddying; setting up bike buses; providing commuter-oriented cycle skills training workshops; installing secure cycle parking; providing cycle fleets for use while at work; arranging lease bikes; running puncture and basic maintenance workshops and providing assistance to plan safe, enjoyable routes to work. | 32% of employees increased their frequency of biking to work; 69% biked more than 1km; 49% replaced driving with biking. |
| Shoup, 1997 | California, USA | Employees | Experiment without control | High | High | High | High | Unknown | Low | High | Low | 1694 | Without | 6 | 6.2 | Cashing out employees’ parking subsidies. | Proportion of employees driving alone decreased from 76% to 63%; ride-sharing increased from 14% to 23%; by transit increased from 6% to 9%; by bike and on foot increased from 3% to 4%. |
| Petrunoff et al., 2015 | Perth, Australia | Employees of two adjoining large hospitals | Clustered quasi-experiment | High | Unknown | High | High | Unknown | Low | Low | High | 9100 (1100, 8000) | With | 1, 3, 6 | 1.1, 3.1, 6.1, 6.2, 6.3 | Hospital 1: provision of an off-site park and ride facility; funding to increase levels of bus services, provision of information to staff, a carpool management system including parking discounts and a matching service and e-bikes; Hospital 2: only encouragement to transit without restrictions of cars. | Encouragement with restrictions outperforms encouragement without restrictions; 37 percentage point increase in the proportion of people driving alone and a significant increase in the proportion of public transport. |

**Table A2** School intervention studies.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference | City, country (region) | Participant description | Type of experiment | Random sequence generation bias | Allocation concealment bias | Blinding of participants and personnel bias | Blinding of outcome assessment bias | Incomplete outcome data bias | Selective reporting bias | Other sources of bias | GRADE level | Number of participants (in each group) | Comparison group | Type of interventions | Sub-type of intervention | Measure | Outcome |
| Sanjust di Teulada and Meloni, 2016; Sottile et al., 2021 | Roma, Italy | Students of Universities of RomaTre with a license | Quasi-experiment | High | High | High | Low | Unknown | Low | High | Low | 50 (37, 13) | With | 1, 2, 6 | 1.1, 2.1, 6.2 | A practical map showing how to use the sustainable travel alternative; a detailed description of the actual individual and environmental effects of the travel behavior adopted (monetary cost, journey time, calories burned and CO2 emissions); personalized slogans and other useful information on sustainable travel; links that provide useful information on mobility. | In experiment group, 12 participants adopted PTP while only 3 adopted for 2 days; 8.1% of the trips altered to sustainable modes. |
| Teixeira et al., 2019 | Oporto, Portugal | Students and parents of an elementary school | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 145 | Without | 1, 3, 6 | 1.1, 3.1, 6.2 | Carpooling, park & stride, school route map, safe parking banners, and the Tree of Life contest. | More difficulties compared with other case-studies with government support, but still could motivate students to change travel patterns. |
| Di Dio et al., 2015, 2018 | Palermo, Italy | Students of Palermo University | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 77 | Without | 1, 2, 5, 6 | 1.1, 2.1, 5.1, 5.5, 6.2 | Gamification rewards to encourage sustainable travel patterns such as walking, biking and ridesharing. Scenario 1: encouraging sustainable travel patterns without restrictions of driving alone; scenario 2: encouraging with restrictions. | Without restrictions: carbon emission lowered by 37%; with restrictions: by 65%. |
| Di Dio et al., 2020 | Palermo, Italy | Students of Palermo University | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 311+46 | Without | 1, 2, 3, 5 | 1.1, 2.1, 3.3, 5.1, 5.5 | Gamification rewards to encourage sustainable travel patterns such as walking, biking and ridesharing. | Through environmental consciousness without rewards can also change travel patterns. |
| Rodriguez and Rogers, 2014 | North Carolina, USA | Incoming undergraduate transfer students and graduate students looking for new residences off campus | Randomized controlled trials | Low | Unknown | High | Low | Low | Low | High | High | 292 (103, 189) | With | 1, 6 | 1.1, 6.2 | Map providing bus routes and locations of apartments, shopping center and campus. | Experiment group had a lower car travelling distances, lived nearer to campus and had more bus stations at the residence. |
| Gutierrez et al., 2014 | Miami, USA | Students of elementary schools | Clustered quasi-experiment | Low | Unknown | High | Low | Unknown | Low | High | Moderate | 2 schools (1, 1) | With | 6 | 6.2 | Add crossing guards at the crossroads near the school and provide related information to students and teachers. | No change in the use of active travel, parental safety concerns, or parental attitudes towards active travel. Significant changes in the likelihood for children to use supervised routes. |
| Mammen et al., 2014a, b | Canada | Students of elementary schools | Experiment without control | High | High | High | High | Unknown | Low | High | Moderate | 103 schools/7827 students | Without | 1, 3, 6 | 1.1, 3.1, 3.3, 6.1 | Infrastructure modifications/additions; safety education; special walking events; walking buddies/walking school bus formation; active school travel newsletter dissemination and identification of best routes to school. | Approximately 17% of the sample reported driving less at one-year follow-up, while infrastructure modifications and safety education most effective. |
| Buliung et al., 2011 | Alberta, Nova Scotia, Ontario, British Columbia, Canada | Students of elementary schools | Experiment without control | High | High | High | High | Unknown | Low | High | Low | 12 schools/1489 students | Without | 3, 6 | 3.1, 3.3, 6.1 | Education, activities and events, capital improvement projects and enforcement of active school travel. | Proportion of walking increased from 43.8% to 45.9%; 13.3% of households drove less. |
| Cuffe et al., 2012 | Boulder, USA | Students of elementary schools | Experiment without control | High | High | High | High | Unknown | Low | High | Moderate | 10207 | Without | 5 | 5.1 | Offering children an opportunity to win 10 dollars if they walk or bike to school. | The riding behavior of participating children increased by 16%. |
| McDonald et al., 2013 | Eugene, USA | Students of elementary schools | Clustered quasi-experiment | Low | Unknown | High | Low | Unknown | Low | High | High | 14 schools (9, 5)/16500 students | With | 3, 6 | 3.1, 6.1 | Education and encouragement programs, and improvement of facilities such as sidewalks, crosswalks and covered bike parking. | Education and encouragement increased proportion of riding by 5%, while with improvement of facilities by 5%-20%. |
| McDonald et al., 2014 | District of Columbia, Florida, Oregon, Texas, USA | Students of elementary schools | Clustered quasi-experiment | Low | Unknown | High | Low | Unknown | Low | High | High | 801 schools (378, 423)/4090 students | With | 3, 6 | 3.1, 6.1 | Education and encouragement programs, and improvement of facilities such as sidewalks, crosswalks and covered bike parking. | Improvement of facilities increased proportion of riding by 18%, while with education and encouragement by 25%. |
| Mendoza et al., 2011 | Houston, USA | Students of elementary schools living within 1 mile of school | Clustered randomized controlled trials | Low | Unknown | High | Low | Low | Low | High | High | 8 schools (4, 4)/149 students (70, 79) | With | 3, 7, 8 | 3.1, 7.1, 8.1 | Study staff walked with children to and from school up to 5 days/week to cultivate their habits to walk to school. | In experiment group, proportion of walking and biking to school increased from 23.8% to 54%; in control group, decreased from 40.2% to 32.6%. |
| McKee et al., 2007 | West Dunbartonshire, UK | Students of elementary schools | Quasi-experiment | High | High | Unknown | Unknown | Unknown | Low | High | Low | 55 (29, 26) | With | 1, 3, 6 | 1.1, 1.2, 3.1, 6.2 | A customized map of the school community illustrated the core path networks linking the wider community to the school, a distance and time chart provided information about journey times on foot, weekly goal-setting activities to help children and their families get ready to walk and set goals for changing their travel to school behavior. | In experiment group, mean distance travelled to school by walking increased by 389%, while mean distance decreased by 57.5%. |
| Mendoza et al., 2009 | Seattle, USA | Students of elementary schools | Clustered quasi-experiment | High | High | Unknown | Unknown | Low | Low | High | Moderate | 3 schools (1, 2)/653 students | With | 3, 7, 8 | 3.1, 7.1, 8.1 | Study staff walked with children to and from school up to 5 days/week to cultivate their habits to walk to school. | In experiment group, more students walked to school; in control group, no change detected. |
| Wen et al., 2008 | Sydney, Australia | Students of elementary schools | Clustered quasi-experiment | Low | High | High | Low | Unknown | Low | High | High | 1277 (683, 594) | With | 3, 6 | 3.1, 3.3, 6.1, 6.2 | Providing information with information about influence of climate change and costs of active travel and driving and routes and timetables of bus and train. Safety and convenience of walking environment offered by local councils. | In experiment group, higher proportion of participants walking to school than that in control group. |

**Table A3** Unspecified intervention studies.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference | City, country (region) | Participant description | Type of experiment | Random sequence generation bias | Allocation concealment bias | Blinding of participants and personnel bias | Blinding of outcome assessment bias | Incomplete outcome data bias | Selective reporting bias | Other sources of bias | GRADE level | Number of participants (in each group) | Comparison group | Type of interventions | Sub-type of intervention | Measure | Outcome |
| Ahmed et al., 2020 | Hasselt, Belgium | Adult citizens who have driving license, smartphones and have sufficient knowledge of e-mail based communication | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | Moderate | 52 (40, 12) | With | 1, 2, 3, 4 | 1.1, 2.1, 3.3, 4.1 | A brief introduction containing background information to increase individual awareness about the negative impact of the current travel behavior such as car dependency, tailored feedback in terms of a quantitative measure about CO2 emissions of the individual current travel behavior and its comparison with the average value in a study group, personalized pro-environmental travel plans to decrease car use dependency, and individuals to be asked to give their commitments for some of the suggested personalized pro-environmental travel plans. | Carbon emission decreased by 4.25%; physical activity level increased by 6.10%. |
| Polydoropoulou et al., 2019; Tsirimpa et al., 2019 | Birmingham, UK, Vienna, Austria | Young, educated individuals, tech avid | Quasi-experiment | High | High | High | Low | Unknown | Low | High | Low | 76 (64, 12) | With | 5 | 5.1, 5.5 | Financial incentives (Vienna: direct, monetary rewards; Birmingham: indirect, public transport tickets and shopping vouchers). | Incentives increased individuals’ time spent in public transport usage and walking by about 21 min and 14 min per day respectively; the effect differed from different cities and different type of incentives. |
| Hsieh et al., 2017, 2019 | Taipei, Taiwan China | (1) Living in Taipei City from the previous week to the following month, (2) having a car driving license, (3) owning a car or having access to a car owned by others, and (4) not being a professional driver | Randomized controlled trials | Low | Unknown | High | Low | Low | Low | Low | Moderate | 121 (41, 38, 42) | With | 1 | 1.1, 1.3 | Personalized travel information (action plan), figure out difficulties in sustainable travel and try to solve them (coping plan). | Action plan could not lower usage of cars directly alone, but with coping plan could. |
| Fujii and Kitamura, 2003 | Kyoto, Japan | Students of Kyoto University, residing and using automobiles in Kyoto | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | Moderate | 43 (23, 20) | With | 6 | 6.2 | A one-month free bus ticket and a bus route map of Kyoto. | Bus use frequency increased, car use frequency decreased, and the effect could last for a long time. |
| Minnich et al., 2021 | Oberharz, Germany | Various people | Randomized controlled trials | Low | High | High | Low | Unknown | Low | High | High | 1425 (1012, 413) | With | 3, 5 | 3.3, 5.1, 5.5 | Indirect financial incentives (gift vouchers) and information incentives (environmental certificates reporting saved carbon dioxide). | Compared with certificates, gift vouchers had a stronger effect in motivating travelers to choose demand-response bus. |
| Meloni et al., 2017 | Cagliari, Italy | Car drivers along the most congested corridor, where a competitive but underutilized light rail had been operating along the same corridor for about 2 years | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 109 | Without | 1, 2, 3, 6 | 1.1, 2.1, 3.1, 6.2 | Analysis of actual individual information and activity travel behavior, devising alternative travel scenarios and simulation of the PTP to be proposed with feedback including weekly time spent driving, money spent, CO2 emitted, and calories burned. | The effect of turning to light rail is different for people with different characteristics. |
| Jariyasunant et al., 2015 | California, USA | Students and staff of University of California Berkeley XLab | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 135 | Without | 1, 2, 3, 4, 6 | 1.1, 2.1, 3.1, 4.1, 6.2 | Personalized travel information (time, money, calories and CO2 spent travelling), comparison with other people and changing trends. | Personalized travel information had effect in the choice of travel mode. |
| Piras et al., 2018 | Cagliari, Italy | Car drivers along the most congested corridor, where a competitive but underutilized light rail had been operating along the same corridor for about 2 years | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | High | 544 (435, 109) | With | 1, 2, 3, 6 | 1.1, 2.1, 3.1, 3.3, 6.2 | A practical map showing the route to reach the light railway station, personalized slogans and other useful information on sustainable travel in general and specifically on use of the light railway, links that provide useful information on mobility, a detailed description of the actual individual and environmental effects of the travel behavior adopted. | Soft measure (travel information) could help hard measure (operation of infrastructure such as light rail) to motivate public transport travel from motorized travel; effects of carbon emission, time, money and heat burning on the change of travel mode decreased successively. |
| Guo and Peeta, 2020 | Tippecanoe County, USA | Newly hired employees before relocation | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | High | 282 (147, 135) | With | 1, 6 | 1.1, 6.2 | Personalized neighborhood accessibility information before relocation that characterizes the ease of access of each neighborhood for six trip purposes (work, healthcare, social or recreational, restaurants, education, and retail or grocery shopping) using walk, bike, transit, or car mode. | Personalized travel information made participants think more about travel related issues before relocation so as to choose location which could solve travel problems better, thus decreasing car usage and increasing walking and public transport. |
| Bowden and Hellen, 2019 | Bologna, Italy | Everyday car users | Experiment without control | High | High | High | High | Unknown | Low | High | Low | 667 | Without | 1, 2, 5, 6 | 1.1, 2.1, 5.1, 5.5, 6.2 | Participants had several opportunities to earn points, primarily through the basic action of tracking a journey, earning points, and then redeeming vouchers. Points could also be earned by achieving specific goals, such as the first sustainable trip of the day or cycling/walking at least 150 min per week. | 47% of the participants performed continuous change in travel behavior. |
| Cooper, 2007 | King County, USA | Various people | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 212 | Without | 1, 3, 5, 6 | 1.1, 5.1, 5.5, 6.2 | Through community-based social marketing, community publicity was carried out to provide residents with community-based and individual-based information incentives and economic incentives to affect people’s transportation awareness and behavior. | Proportion of public transport, ridesharing, biking and walking increased; proportion of driving alone decreased by 24%-50%, proportion of public transport increased by 20%-50%. |
| Rea and Ryan, 2007 | San Diego, USA | Various people | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 29 | Without | 6 | 6.2 | Discount monthly path; free public transport and ridesharing after payment. | Participants were satisfied with the program, had a better impression of public transport and decreased distance of driving alone significantly. |
| Bothos et al., 2014 | Vienna, Austria | Various people | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 24 | Without | 1, 2, 3 | 1.1, 2.1, 3.3 | Recording journey tracks and carbon emission through APP; offering personalized emission reduction suggestions. | Participants, especially those who drove, became aware of unsustainable travel modes; some changed to public transport or chose more sustainable routes when driving. |
| Bamberg and Rees, 2017 | Munich, Germany | New residents | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | High | 606 (288, 318) | With | 1, 3, 6 | 1.1, 3.1, 6.2 | An individualized welcome letter on residence; a brochure containing information about local public transport, cycling and walking; a city map showing all public transport routes and stops; and a ‘service card’ used for requesting additional information brochures or one-week free public transport pass. | Compared with control group, experiment group decreased car use by 5.6 percentage points and increased public transport by 9.8 percentage points. |
| Bamberg, 2006 | Stuttgart, Germany | Residents, shortly after a residential relocation | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | High | 169 (79, 90) | With | 1, 3, 6 | 1.1, 3.1, 6.2 | Free public transport pass; personalized timetable. | For experiment group, proportion of public transport increased from 18% to 47% after changing residency, while for control group only to 25%. |
| Bamberg, 2013 | Berlin, Germany | People own or have access to a car | Randomized controlled trials | Low | Unknown | High | Low | Low | Low | Low | High | 291 (68, 105, 118) | With | 1, 6 | 1.1, 6.2 | Some only standardized information (information of public transport, walking and cycling paths and ridesharing services); some with personal talk. | Only standardized information could not decrease car usage and increase public transport usage, but personal talk could, while car usage mostly changed to public transport usage. |
| Eriksson et al., 2008 | Sweden | (1) At least one member of the household had a driving license, (2) there was at least one car in the household, (3) there were no children 18 years of age or older with a driving license in the household, (4) the car was used at least once a week for personal trips, and (5) the car was not used for business trips more than three times a week | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | Moderate | 51 (22, 29) | With | 1 | 1.1, 1.3 | Provide possible option for participants to decrease car travelling to help them realize the option. | Car use habit could hardly be affected by intervention, but relation between car usage and car use habit decreased, while relation between car usage and personal characteristics increased, proving that car usage being more rational. |
| Gärling et al., 1998 | Umeå, Sweden | Car-owning households with two adult members and at least one pre-adolescent | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | Moderate | 78 (40, 38) | With | 1 | 1.1 | Attempting to reduce car use by considering whether to suppress it, combine it with some other trip, choose a closer destination, get a ride with somebody else, or choose another travel mode. | Car usage of experiment group lower than control group. |
| Gothenburg, Sweden | Car-owning households with two adult members and at least one pre-adolescent | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | High | 130 (93, 37) | With | 3, 6 | 3.1, 6.2 | Provide regular timetable or personal timetable. | Timetable information had no effect in reducing car usage. |
| Garvill et al., 2003 | Umeå, Sweden | Household owning one car and none of the subjects older than 64 years old | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | High | 115 (64, 51) | With | 1 | 1.1 | Provide travel related background information to let participants know more about different travel modes. | Related information had no significant effect to overall car usage. |
| Geng et al., 2016 | Xuzhou, China | Car-owning households | Randomized controlled trials | Low | Unknown | High | Low | Low | Low | Low | High | 392 (191, 201) | With | 1, 3 | 1.1, 3.2, 3.3 | Three groups of participants according to travel goals (hedonic, gain, green); six aspects of information: (1) health benefits of walking and using a non-powered bicycle; (2) freedom, convenience, and safety of walking, riding a non-powered bicycle, and using the bus; (3) individual economic costs of car use; (4) social costs of car use; (5) environmental losses due to car use; (6) travel awareness campaigns and government activities relative to green travel. | Significant improvement in sustainable travel but unsignificant in car usage reduction; least effect to hedonic group, then to green group, most effect to gain group. |
| Haq et al., 2008 | City of York, UK | People who were predominantly car dependent and receptive to re-thinking how they travel | Quasi-experiment | High | High | High | Low | Low | Low | High | Moderate | 119 (81, 38) | With | 1, 3, 6 | 1.1, 3.1, 6.2 | Face-to-face discussions, personalized information (public transport, car share, walking and cycling) and incentives (six-month free bus pass, cycle map, pedometer and walking map). | Proportion of public transport and biking increased, proportion of car decreased; the trend lasted for up to 6 months, but could not last for 12 months. |
| Ma et al., 2017; Mulley and Ma, 2018 | Adelaide, Australia | Individuals in the households aged over 14 | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 144 households | Without | 1, 2, 3, 6 | 1.1, 2.1, 3.1, 6.2 | A brochure providing step by step instructions to plan journey by public transport and bike, a map for people who wanted to walk/cycle more or take a specific route, a letter to praise past reduction in car km and to reinforce the benefits, a letter to remind participant of the changes they committed to during the conversation, guides to local shops, services, clubs and activities to assist people to use local alternatives. | Reduced the car trips soon after implementation significantly with longer term effects on reducing car trips in high-walkable neighborhoods. |
| Nakayama and Takayama, 2005 | Ishikawa, Japan | Students of Kanazawa University and Ishikawa National College of Technology having their own cars | Quasi-experiment | High | High | High | Low | Low | Low | High | Moderate | 152 (15, 44, 92) | With | 1, 2, 3, 8 | 1.1, 1.3, 2.3, 3.1, 8.1 | Organizing ecotravel coordinator program in which organizers analyzed their and participants’ travel behavior, discussed about reduction of car usage, educate participants and gave them suggestions. | For organizers, car travel mileage decreased by 54%, for participants 48%, for nonparticipants only 1.4%. |
| Sargeant et al., 2004 | Cambridgeshire, UK | Senior staff and new staff of Cambridgeshire County council | Randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | Low | High | 713 (358, 355) | With | 1 | 1.1 | Personalized contact and travel advice. | For senior staff, mileage of driving alone decreased, for new staff no significant effect. |
| Foxx and Schaeffer, 1981 | District of Columbia, USA | Employees | Quasi-experiment | Low | High | High | Low | Unknown | Low | Low | Moderate | 15 (8, 7) | With | 4, 5 | 4.1, 5.2 | A month-long lottery in which the experimentals were rewarded for decreasing their percentage of average miles driven per day relative to their initial baseline average (every week & end of the month). | For experiment group, average daily mileage decreased by 11.6%, while for control group 21.2%; the effect could not last for long after experiment. |
| Jakobsson et al., 2002 | Gothenburg, Sweden | Two-adult households who were owners of at least one car | Clustered randomized controlled trials | Low | Unknown | High | Low | Unknown | Low | High | Moderate | 80 households | With | 1, 2, 5 | 1.1, 2.1, 5.6 | Charge according to car use mileages for 2 weeks; charge according to car use mileages for 2 weeks/4 weeks with a request to fill out a prospective car plan for the following week. | Charge only could not have significant effect in reducing car usage, while plan for future car usage could. |
| Tertoolen et al., 1998 | Goula, Netherlands | Main car users in their families | Randomized controlled trials | Low | Unknown | High | Low | Low | Low | High | High | 350 | With | 1, 2, 3 | 1.1, 1.2, 2.1, 3.3 | Information and individual feedback about the effects of car use on the environment and/or on own finances every two weeks, information on public transport applicable to situation; commitment to reduce car use mileage. | No significant effect for every intervention. |
| Foxx and Hake, 1977 | Baltimore, USA | Students of Maryland University owning or co-owning a car | Quasi-experiment | High | High | High | Low | Unknown | Low | Low | Low | 21 (12, 9) | With | 5 | 5.1 | Cash, a tour of a mental-health facility, car servicing, and a university parking sticker for reducing driving. | For experiment group, average car use mileage decreased by 20% from baseline. |
| Gabrielli and Maimone, 2013a, b | Trento, Italy | People with a relatively long travelling distance | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 8 | Without | 1, 2, 5, 8 | 1.1, 1.2, 2.1, 5.3, 8.1 | Weekly goal setting for mode of transport to use (car, carpooling, bicycle, walking, public transport), self-monitoring of previous travel choices made, encouraging message rewards and goal realization sharing. | Proportion of sustainable travel mode increased from 32% to 46%. |
| Gabrielli et al., 2014 | Trento, Italy | Various people | Quasi-experiment | High | High | High | Low | Unknown | Low | Low | Moderate | 12 (7, 5) | With | 1, 2 | 1.1, 1.3, 2.1 | A journey planner for public transportation, automatic detection of trips and transport modes, trip history, visual feedback on the weekly CO2 emissions and a set of actionable challenges designed to motivate the user to choose more sustainable transport modes and trips (only for experiment group). | No significant differences between groups. |
| Barcelona, Spain, Milan, Italy, Helsinki, Finland | Various people | Experiment without control | High | High | High | High | Low | Low | High | Low | 471 | Without | 1, 2 | 1.1, 1.2, 2.1 | Multimodal journey planner, reporting disruptive events, goal-setting, self-monitoring, and rewarding features. | No significant differences in travel mode choice, carbon emission and attitudes before and after experiment. |
| Kazhamiakin et al., 2015 | Rovereto, Italy | Various people | Experiment without control | High | High | High | High | Low | Low | High | Very low | 20 | Without | 1, 2 | 1.1, 2.1 | Sustainable mobility recommendations, gamification incentive framework (green points (related to mileage travelled with sustainable transportation means), health points (related to mileage travelled biking or walking) and park & ride points (related to repeated usage of park & ride facilities)). | Gamification incentive framework could motivate sustainable travel and decrease car usage. |
| Wunsch et al., 2015 | Massachusetts, USA | Students of MIT, non-routine bikers | Randomized controlled trials | Low | High | High | Low | Unknown | Low | Low | Moderate | 44 (12, 11, 11, 10) | With | 1, 2, 3, 4, 6 | 1.1, 1.2, 1.3, 2.1, 2.3, 3.1, 4.1, 6.2 | Group 1: frequent biking challenge (triggering: emails offering information about performance in the challenge and acting as a trigger for biking, recognition: points and different statuses depending on the number of reported bike trips, competition, cooperation, and social comparison); group 2: virtual bike tutorial; group 3: bike buddy program. | 13.5% more biking in group 1, no significant difference but higher self-efficacy in group 2, low completion rate, no significant difference but positive experience in group 3. |
| Taniguchi and Fujii, 2006; Taniguchi et al., 2005 | Obihiro, Japan | Various people | Randomized controlled trials | Low | High | High | Low | Low | Low | Low | High | 495 (410, 85) | With | 1, 3, 6 | 1.1, 3.1, 6.2 | Advertising leaflet, travel behavioral plan sheet and two free bus tickets. | Increase in bus use proportion. |
| Fujii and Taniguchi, 2005 | Sapporo, Japan | Students of elementary schools and their family | Randomized controlled trials | Low | High | High | Low | Unknown | Low | High | High | 292 (155, 137) | With | 1, 2, 3 | 1.1, 2.1, 3.1, 3.3 | Lessons in advance on the global warming issue, the role of CO2 in this problem, and the level of CO2 emission from car-use; advice group: fill in a 3-d activity-travel diary; planning group: develop behavioral plans to modify home-based car trip chains with the aim of reducing CO2 emissions. | No significant effect in advice group, while significant car usage in planning group. |
| Taniguchi et al., 2003 | Sapporo, Japan | Residents and students of elementary schools and their family | Experiment without control | High | High | High | High | Unknown | Low | High | Low | 599 | Without | 1, 2, 3, 4 | 1.1, 2.1, 3.1, 4.1 | A pamphlet outlining travel behavior modification programs; lists of family members and cars, a travel activity diary and a car-use diary; diagnostic checklists for feedback of CO2 emissions and final diagnostic checklists comparing multiple diaries. | Car usage decreased by 5%; public transport increased by 4%; CO2 emissions decreased by 16.3%; long term effect found. |
| Matsumura et al., 2003 | Osaka, Japan | Various people | Randomized controlled trials | Low | High | High | Low | Low | Low | High | High | 106 (23, 20；30, 33) | With | 1, 2, 3 | 1.1, 2.1, 3.1 | Travel diaries of one week/one day, plans to decrease car usage accordingly. | Travel diaries of one week had more significant effect. |
| Taniguchi et al., 2002 | Sapporo, Japan | Students of elementary schools and their family | Experiment without control | High | High | High | High | Low | Low | High | Very low | 127 | Without | 1, 2, 3 | 1.1, 2.1, 3.1, 3.3 | Materials including a panel showing benefits and detriments of family car use, a graph showing the share of CO2 emissions by source, and a panel clearly illustrating various TDM policies; schedule for diary surveys and lectures, and content of the lecture discussed with the teacher; visible travel diary and personalized advice. | Change in household travel patterns; total carbon emissions decreased by approximately 10%. |
| McMinn et al., 2012 | Scotland, UK | Students of elementary schools | Quasi-experiment | High | Unknown | Unknown | Unknown | Unknown | Low | High | Moderate | 166 (79, 87) | With | 1, 3 | 1.1, 1.2, 3.1 | For teachers, handbook containing introductory activities to the intervention and lesson plans on topics; for pupils, materials encouraging pupils to set walking goals and to record how to travel to and from school each day. | No significant effect. |
| Matthies et al., 2006 | Bochum, Dortmund, Germany | Participants had a real choice between different travel modes, have a driver’s license and access to a car. | Randomized controlled trials | Low | High | High | Low | Low | Low | Low | High | 297 (130, 61, 53, 53) | With | 1, 6 | 6.2 | A habit-defrosting technique (temporary gift of a free bus ticket) and/or a norm-focused technique (plea for commitment). | For free bus ticket or commitment, both managed to let some people triy to change travel modes, but amount of which was limited; in short term, free bus ticket was effective; in long term, combining both was most effective. |
| Sochor et al., 2015 | Gothenburg, Sweden | Inner-city households having sufficient access to the existing transport solutions, in particular to carsharing and public transport, and large enough travel needs for the service to be financially competitive with their current solution | Experiment without control | High | High | High | High | Low | Low | High | Very low | 160 | Without | 6 | 6.2 | MaaS platform offering information and service of multiple travel mode. | Decrease in car usage; participants’ attitude towards car usage turned to negative. |
| Karlsson et al., 2017 | Gothenburg, Sweden | Various people | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 200 | Without | 6 | 6.2 | MaaS platform offering information and service of multiple travel mode. | 48% of participants changed their travel mode; 55% used multimodal travel mode more frequently; 60% used software to get new paths for leisure trips; 69% found new paths to be faster; 48% travelled by public transport more frequently, 10% public bikes, 4% electric carsharing, 4% electric bike while 21% cars less frequently. |
| Chang et al., 2019 | Taipei, Taiwan China | Various people | Experiment without control | High | High | High | High | Unknown | Unknown | High | Moderate | >1000 | Without | 6 | 6.2 | MaaS platform offering information and service of multiple travel mode, and month ticket. | Within 3 months’ trial, usage of public transport increased by 2%; after trial, usage of public transport increased by 3.2%, of which 80% from trial users. |
| Kaohsiung, Taiwan China | Various people | Experiment without control | High | High | High | High | Unknown | Unknown | High | Moderate | >15492 | Without | 6 | 6.2 | MaaS platform offering information and service of multiple travel mode, and month ticket. | Within 3 months’ trial, 94.4% of users continued to use MaaS, of which 21% from motorized vehicle users. |
| Storme et al., 2020 | Ghent, Belgium | Car-owning participants Ghent University employees | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 90 | Without | 6 | 6.2 | MaaS platform offering information and service of multiple travel mode. | Most respondents were apt to explore MaaS services (especially public transport and car sharing services), but a clear reduction of private car use remained difficult in a real-life setting, especially for leisure trips. |
| Zhao et al., 2020 | Sweden | Employees | Experiment without control | High | High | High | High | Unknown | Low | High | Low | 355 | Without | 6 | 6.2 | MaaS platform offering information and service of multiple travel mode. | Around 50% showed a willingness to share their ride through MaaS, but current service could not change car users’ intention significantly. |
| Hensher et al., 2021 | Sydney, Australia | Various people | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 92 | Without | 6 | 6.2 | MaaS platform offering information and service of multiple travel mode, and month ticket. | Travel fee discount was effective in attracting users and reducing car usage, while only integration of service had weak effect. |
| Poslad et al., 2015 | Enschede, Netherlands, Gothenburg, Sweden, Leeds, UK | Various people | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 268+112+138 | Without | 1, 2, 5 | 1.2, 2.1, 5.1 | Social network sharing: travel information, GPS positions, partner finding and specified position finding; self feedback of personal travel behavior; behavior challenge based on rewards. | The level and use of non-tangible rewards could hardly influence users much to shift their behavior to act greener. The level of personalization could be an important characteristic for the effectiveness of an incentive. It might be feasible to make car drivers change their departure time, but hard to induce car drivers to change to public transport. It might be feasible to induce public transport users to change to cycling. Social network concepts were rated best when these provide information useful for the individual, but sharing information and experiences could hardly contribute to shifting travel behavior. |
| Pronello et al., 2017 | Lyon, France | Various people | Experiment without control | High | High | High | High | Unknown | Low | High | Very low | 46 | Without | 6 | 6.2 | Map software offering real-time travel information. | Offering real-time travel information only had no effect in modal shift. |
| Merom et al., 2005 | Australia | Urban dwelling ‘‘working-age’’ (18–65 years old) adults. | Experiment without control | High | High | High | High | Low | Low | High | Moderate | 1100 | Without | 6 | 6.2 | Newspaper advertisements and community service announcements through three major free-to-air television channels and radio stations nationally. | In New South Wales, “car only” and “public transport only” decreased while trips combining walking and public transport increased; in other regions, “walking/cycling only” decreased while trips combining walking and public transport increased. |
| Thomas et al., 2009 | Columbia, USA | Students of elementary schools | Experiment without control | High | High | High | High | Unknown | Low | High | Low | 400 | Without | 3, 6, 8 | 3.1, 6.2, 8.1 | Lessons for teaching biking; staff leading students to commute; funding bikes for poor households. | 75% of participants rode more frequently; 35% replaced car travel with cycling. |
| Alcott and Decindis, 1991 | Maricopa County, USA | Car-owners | Experiment without control | High | High | High | High | Unknown | Low | High | Low | 701 | Without | 1, 3 | 1.2, 3.3 | Campaign about decreasing air pollution, asking drivers to reduce their vehicle-miles by not driving their car 1 day per week and informing participants that car usage is the main source of carbon monoxide. | Commuting by driving alone decreased by 3%; commuting by biking increased by 1%; commuting traffic during morning peak decreased by 2%, total traffic stayed as usual; bus ridership increased. |
| Aittasalo et al., 2012 | Southern Finland, Finalnd | Employees | Randomized controlled trials | Low | High | High | Low | Low | Low | Low | High | 241 (123, 118) | With | 2, 3, 6 | 2.1, 3.2, 6.2 | One group meeting and six e-mail messages about benefit of walking and physical activity to health and log-monitored pedometer-use. | After 2 months, “walking for transportation” increased; after 6 months, "walking for leisure" increased; “walking stairs” increased at 2 and 6 months; the effect lasted for a long period of time. |
| Hemmingsson et al., 2009 | Stockholm, Sweden | Obese women | Randomized controlled trials | Low | High | High | Low | Low | Low | Low | High | 120 (60, 60) | With | 2, 3, 6, 8 | 2.1, 3.2, 6.2, 8.1 | Group 1: physician meetings, physical activity prescriptions, group counselling and bicycles; group 2: low-intensity group support with pedometers. | In group 1, cycling increased by 38.7%, significantly higher than that in group 2 (8.9%); no significant effect in walking, significant effect in reducing travelling by cars and public transport. |
| Skarin et al., 2019 | Värmland, Sweden | Car-owners | Experiment without control | High | High | High | High | Low | Low | High | Very low | 181 | Without | 6 | 6.2 | A free travel pass valid for two weeks throughout the region. | Greater self-efficacy and social support during the intervention of free travel pass, leading to greater travel behavior change. |
| Arroyo et al., 2018 | Valencia, Spain | Various people | Quasi-experiment | High | High | High | Low | Unknown | Low | Low | Moderate | 118 (72, 46) | With | 1, 2, 3, 6 | 1.1, 2.1, 3.2, 6.2 | A report with participants’ mobility information, together with general information concerning transit supply available in their neighborhood; a talk given by a cardiologist and a sports trainer on the relationship between health and physical activity and how walking and riding a bicycle can improve their health; a video session where people who had recently reduced car use were interviewed on the street about why they had decided to do so. | The individuals most affected were those carrying out solo and afternoon trips. If traveling with companions, those who did so with household members were more influenced |
| Nielsen and Haustein, 2019 | Denmark | Various people | Experiment without control | High | High | High | High | Unknown | Low | High | Moderate | 11798 | Without | 1, 2, 3, 8 | 1.1, 1.2, 2.1, 3.2, 8.1 | Various activities to promote programs to increase cycling (national media activities, social-media campaigns and distribution of small incentives); more general information about cycling and health provided via different media channels and at doctors and health centers aiming for awareness raising among people who had not formed an intention to increase cycling yet; for people who already had an intention to increase cycling, help to set a realistic goal, support goal achievement by feedback, self-monitoring and social support. | Significant effect in promote cycling. |

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