Air pollution: outdoor air quality and health

Draft Evidence review 3 on: Travel Planning and other initiatives providing information, advice, education and skill development

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1 Introduction

This evidence review is the third of a series conducted to support the development of guideline on road transport related air pollution. The scope for the guideline is available here.

This review addresses Topic 3: Travel Planning and other initiatives providing information, advice, education and skill development, as set out in the review protocols. The following questions were included in this topic:

- Review question 9: Are settings-based travel planning (such as in workplaces, new residential developments or schools) interventions effective and cost effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?
- Review question 10: Are personalised travel planning interventions to support low emission travel choices effective and cost effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?
- Review question 11: Are driver information, education and training interventions effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

2 Methods

This review was conducted according to the methods set out in Developing NICE guidelines: the manual (NICE 2014).

2.1 Review questions

Review question 9: Are settings-based travel planning (such as in workplaces, new residential developments or schools) interventions effective and cost effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

Review question 10: Are personalised travel planning interventions to support low emission travel choices effective and cost effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

Review question 11: Are driver information, education and training interventions effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

2.2 Searching, screening, data extraction and quality assessment

See Review 1, Section 2.2 for details.

3 Results

3.1 Flow of literature through the review

Ten studies were included in the current evidence review. The flow of literature and a brief summary of reasons for exclusion at full text for all the reviews is included in Review 1, Section 3.

3.2 Characteristics of the included studies

Full details of the included studies are given in the evidence tables in Appendix 1. Table 3.2.1 (RQ9), Table 3.2.2 (RQ10) and Table 3.2.3 (RQ11) below show in which country the studies were conducted, and provide a brief summary of the interventions and settings investigated in these studies.

3.2.1 Review question 9: Are settings-based travel planning (such as in workplaces, new residential developments or schools) interventions effective and cost effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

First author, year	Design	Country	Setting	Intervention	QA rating
Organisational travel plans – effectiveness studies					
Sargeant, 2004[8]	Randomised Controlled study	UK	Addenbrooke's NHS Trust and Cambridgeshire County Council	Workplace travel planning	-
Watts, 2000[9]	Before and after study	UK	University of Sheffield	Employer transport plan	-
Organisational travel plans – qualitative studies					
Watts, 2000[9]	Qualitative study	UK	University of Sheffield	Employer transport plan	-

3.2.2 Review question 10: Are personalised travel planning interventions to support low emission travel choices effective and cost effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

First author, year	Design	Country	Setting	Intervention	QA rating
Personalised travel planning					
Nakayama, 2005[5]	Controlled before and after study	Japan	Kanazawa University and Ishikawa National College of Technology	Ecotravel coordinator programme	-

3.2.3 Review question 11: Are driver information, education and training interventions effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

First author, year	Design	Country	Setting	Intervention	QA rating
Dynamic eco-driving					
Barth, 2009[1]	Modelling study	US	Freeways	Dynamic eco driving	-
Driver information and training – effectiveness studies					
Caulfield et al., 2014[3]	Controlled trial	Netherlands	In-car and online	Eco-driving feedback tool	-
Rutty et al., 2013[6]	Uncontrolled before and after study	Canada	Municipal fleets	Eco-driver training	-
Driver information and training – qualitative studies					
Campbell-Hall et al., 2011[2]	Qualitative study	UK	Drivers, employers and fleet managers	Eco-driver training	+
Anti-idling campaigns					
Eghbalnia et al., 2013[4]	Uncontrolled before and fter study	USA	Schools	Anti-idling educational messages	-
Ryan et al., 2013[7]	Uncontrolled before and after study	USA	Schools	Anti-idling educational messages	-

3.3 Study Findings

3.3.1 Review question 9: Are settings-based travel planning (such as in workplaces, new residential developments or schools) interventions effective and cost effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

Two studies were included in the review. The quality of the studies was poor with both studies graded [-] (see Table 3.2.1).

Sargeant et al (2004)[8] [-] looked at whether targeting new starters (and existing car park users) with personalised travel information was an effective means of securing changes to travel behaviour. The study was carried out with new recruits joining Addenbrooke's NHS Trust and Cambridgeshire County Council (Shire Hall site) as well as existing employees at Cambridgeshire County Council with access to the on-site car park. Employees were divided into control and experimental groups. Based on a meeting with an advisor, an information pack of individually tailored travel information was delivered to the employee. No further incentives (such as pedometers or free bus tickets) were offered. Modal split and travel perception data for both groups was collected after 3 months.

Table 1. Modal share at Week 1 and Month 3 stages

		% of car alone trips (actual numbers in brackets)		% of trips by all other modes (actual numbers in brackets)	
		Week 1	Month 3	Week 1	Month 3
Addenbrooke's NHS Trust New Recruit Project	Experiment	26.5% (208)	28.9% (228)	73.5% (577)	71.1% (562)
	Control	33.0% (284)	35.2% (303)	67.0%* (576)*	64.8% (557)
Cambridgeshire County Council New Recruit Project	Experiment	45.5% (125)	45.1% (124)	54.5% (150)	54.9% (151)
	Control	51.9% (122)	56.2% (132)	48.1%* (113)*	43.8% (103)
Cambridgeshire County Council Car Park Access Group	Experiment	70.0% (503)	60.9% (441)	30.0% (216)	39.1% (283)
	Control	69.1% (461)	74.7% (508)	30.9% (206)	25.3% (172)
Cambridgeshire County Council sub-projects combined	Experiment	63.2% (628)	56.6% (565)	36.8% (366)	43.4% (434)
	Control	64.6% (583)	69.9% (640)	35.4%* (319)*	30.1% (275)

*Control group figures for 'all other modes' in Week 1 inferred from other data collected

Table 2. Percentage of individuals driving alone for 5 days a week at Week 1 and Month 3 stages

		% of individuals driving alone for 5 days a week (actual numbers in brackets)	
		Week 1	**Month 3**
Addenbrooke's NHS Trust New Recruit Project	Experiment	19.6% (31)	24.7% (39)
	Control	29.1% (50)	30.2% (52)
Cambridgeshire County Council New Recruit Project	Experiment	38.2% (21)	32.7% (18)
	Control	46.8% (22)	48.9% (23)
Cambridgeshire County Council Car Park Access Group	Experiment	56.6% (82)	41.4% (60)
	Control	44.1% (60)	64.0% (87)
Cambridgeshire County Council sub-projects combined	Experiment	51.5% (103)	39.0% (78)
	Control	44.8% (82)	60.1% (110)

Addenbrooke's NHS Trust

Total number of car trips alone increased by 2.2% in the experiment group relative to the control group[a]. The number of individuals making 5 trips by car alone in the week was 5.5% higher (30.2 % against 24.7%) in the control group compared to the experiment group at the 3-month stage of the project. The changes between Week 1 and Month 3 are not statistically significant (chi-squared =0.37, p = 0.54). There was no evidence of modal shift at the hospital in terms of reducing car alone trips. Furthermore, there was no significant difference between the experiment and control groups at the 3-month stage in terms of the number travelling to work 5 days a week by car alone. The authors suggest a number of potential contributing factors which could explain this:

- All employees at Addenbrooke's receive travel information before starting work
- Previous work on driving to the site had reduced the proportion of individuals driving alone to the site from 50% in 2000 to 34% in 2003, so that it may be possible that Addenbrooke's has already achieved its optimal modal split
- Shift work for nursing staff does not dovetail with bus or Park and Ride services
- 70% of staff are not able to take advantage of flexible working opportunities.

Cambridgeshire County Council (combined sub-group data)

Both County Council experimental showed a beneficial change in numbers of people travelling alone by car on 5 concurrent working days. There was an 18% decrease in

[a] Calculated as (E Week 1 x C Month 3) / (C Week 1 x E Month 3)] –1 where E is the experimental group and C the control group

the number of car alone trips in the experimental group relative to the control group ($p<0.01$ using Mantel-Haenszel Inference for common odds ratio). The number of individuals making 5 trips by car alone in the week was 21.1% higher (60.1% against 39.0%) in the control group compared to the experiment group at the 3-month stage of the project.

The authors note that there were a number of factors which may explain the different outcomes between Addenbrooke's and Cambridgeshire County Council. These include:

- The car parks utilised in the study had different site access policies
- Bus or park and ride services will not dovetail with shift work for employees at the hospital site
- The need to travel as part of work, mainly at the County Council
- Sites were at opposite ends of city, which have different and contrasting public transport provision
- Pre-existing work to reduce driving alone to Addenbrooke's (including 'hard' measures such as the removal of car parking choice) had already resulted in lower levels of car use at that site.

Watts et al (2000)[9] [-] evaluated an employer transport plan introduced at the University of Sheffield to assess the impact on changes in mode of travel to work by employees.

The transport plan introduced a car park management system where staff were only able to park at the university if allocated a chargeable permit. Allocation was given on the basis of need using a points-based criteria system. In total there were 1245 parking spaces available, a number sufficient to enable approximately 20% of staff to park at any one time.

Travel incentives were also used to encourage the use of non-car modes, including:

- The introduction of a park and ride facility between an outlying hall of residence and the university campus;
- Additions to 2 existing bus services;
- Bus passes for sale on campus;
- Extra cycle racks;
- Signposting to ease pedestrian movement within the campus;

- Information on public transport

The results for the modal split before and after the intervention was implemented show that the car remained the dominant means of transport for staff but that there was an overall reduction of 7.3% in car-based journeys amongst respondents.

The authors identified a number of limitations. The availability of on street parking inhibited reductions in car use, therefore those ineligible for a permit or who objected to the principle of paying to park at work could continue to drive to work. Of the regular car drivers, 32% parked outside the university car parks and 21.5% parked on the street.

Incentives had a limited influence. New bus services did not serve the areas where the focus group participants lived and no-one using the park and ride service had switched from car use or had actually parked and ridden. Data from the bus operator also showed low usage for the service.

The authors also carried out a qualitative analysis using focus groups. Five focus groups were undertaken with participants split into types: 2 focus groups contained car users and 3 groups contained those who chiefly relied upon non-car modes of transport. Eight people were invited to each focus group but due to non-attendance of some participants only the car-user groups had 4 or more participants.

Key themes identified were:

- Reductions in car travel. The policy causes a re-evaluation of the journey to work, with employees assessing the merits of car use against the costs and other disadvantages such as traffic congestion.

- Perception of the transport policy. Participants were generally sceptical about the reasons for setting up the transport policy. It was viewed as a means of income generation rather than an environmental policy designed to reduce car use. As such, employees did not think about the environmental implications of their journey to work but were concerned about paying for parking.

- Parking charges. Staff tended to disregard the running costs of owning a car when comparing the cost of car travel against that of other modes. It was also indicated that the charges would need to increase considerably before providing sufficient incentive for them to re-evaluate their travel-to-work behaviour.

- Problems associated with public transport. Participants said that using public transport lengthened the working day due to time spent both travelling and waiting for transport to arrive. Other problems were inadequate services or the lack of a direct public transport route.

- Attitudes to cars and public transport. Some drivers had a more positive attitude towards public transport and had explored the possibilities of using travel alternatives, with some diversifying their travel away from the car on occasions. Other participants preferred to us the car and liked its convenience and flexibility.

Evidence statement 9.1a Effectiveness of organisational travel plans

Weak evidence from 2 [-] studies from the UK[8,9] suggest some modal shift from organisational travel plans.

At a site with relatively low pre-existing car use, provision of information alone did not increase use of alternatives to driving alone (chi-squared =0.37, p = 0.54)[8]. Where there was a higher level of driving alone, information alone[8] or implementation of charging for parking alongside facilities to encourage other modes of transport reduced the number of people driving alone to work by 18% ($p<0.01$) in Cambridge[8], and car-based journeys by 7.3% in Sheffield[9].

Applicability: both studies are from the UK and so the evidence is applicable.

8. Sargeant et al. 2004 (−)

9. Watts et al. 2000 (−)

Evidence statement 9.1b Factors influencing uptake of organisational travel plans

Weak evidence from 1 [-] qualitative study[9] from the UK identified a number of factors which may influence the uptake of organisational travel plans. These included:

- Scepticism about the reasons for setting up the transport policy.
- Disregarding the running costs of owning a car.
- Impact of public transport on the length of the working day.

Development of a travel plan also provided an opportunity to re-evaluate the journey to work. Some drivers showed a more positive attitude towards public transport and had explored the possibilities of using travel alternatives. Other participants preferred to use the car and liked its convenience and flexibility.

Applicability: This study is from the UK and so is applicable.

9. Watts et al. 2000 (−)

3.3.2 Review question 10: Are personalised travel planning interventions to support low emission travel choices effective and cost effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

One study was included in the review. The quality of the study was poor and graded [-] (see Table 3.2.2).

The study examined the effect of an 'ecotravel' coordination programme.

Nakayama et al (2005)[5] [-] examined the impact of an ecotravel coordinator programme aimed at reducing car use amongst students from Kanazawa University and Ishikawa National College of Technology in Japan.

Ecotravel Coordinators were volunteers and each formed their own groups of participants. In total there were 15 groups in the study, with approximately 3 participants and a coordinator in each group (in total 15 coordinators and 44 participants).

The role of the ecotravel coordinator was to:

- organise ecotravel meetings for reducing car use
- analyse travel behaviour of participants and themselves
- take the initiative in the meeting and inspire participants to understand their travel behaviour and improve their environmental attitudes
- give participants advice and suggestions for reducing car use

A survey of travel behaviour was undertaken between 10 - 16 October and a second survey between 12 - 18 December 2002. Ecotravel meetings were held between the 2 surveys.

A group of non-participants (n=92) who were not the subject of the intervention acted as a control group, reporting their travel behaviour for comparison with participants and ecotravel coordinators in the programme.

The ecotravel coordinators and participants of the programme reduced their car travel mileage by 54% and 48% respectively, whereas the non-participants only reduced their mileage by 1.4%. Wilcoxon's signed rank sum tests were used to determine the change in travel mileages between the first and second survey. The results demonstrated that reductions of the coordinators and participants of the ecotravel coordinator programme were statistically significant (Table 4).

Table 4: Change in Car Travel Mileage

	Coordinator		Participant		Non-participant	
	1st Survey	**2nd Survey**	**1st Survey**	**2nd Survey**	**1st Survey**	**2nd Survey**
Mean (km/week)	129.00	59.00	176.54	92.12	176.29	173.99
% change	-54.3		-47.8		-1.3	
Mean difference	-70.00		-84.42		-2.30	
z-value	-2.20**		-3.48***		-0.28	

** p<0.05
*** p<0.01

Mann-Whitney tests were conducted to examine whether the coordinators and participants reduced their car travel mileage more than non-participants, and to eliminate seasonal and weather effects as well as other factors that may influence subjects. The results showed that the coordinators and participants reduced their travel mileage significantly more than did non-participants (Table 5).

Table 5: Differences between types of study participant in Car Travel Mileage Reduction

	Coordinator		Participant	
	Coordinator	**Non-participant**	**Participant**	**Non-participant**
Mean	-70.00	-2.30	-84.43	-2.30
Mean difference	67.70		82.13	
z-value	-1.99**		-2.90***	

** p<0.05
*** p<0.01

Limitations of the study included that the groups differed in size and that participants were selected by coordinators rather than being randomly selected and allocated to an intervention or control group.

Evidence statement 10.1 Effectiveness of personalised travel planning for reducing car use

Weak evidence from 1 [-] study from Japan suggests that personalised approaches coordinated by Ecotravel coordinators, including meetings, encouragement, advice and support, are effective in reducing car use amongst students. Ecotravel coordinators reduced their travel mileage and that of participants to the programme by 54% and 48% respectively, whereas the non-participants only reduced their mileage by 1.4%. The reductions in mileage for both the coordinators and participants were statistically significant. Coordinators and participants also reduced their travel mileage significantly more than did non-participants.

Applicability: The evidence from the study is applicable because the interventions assessed are feasible in the UK context.

5. Nakayama et al. 2005 (−)

3.3.3 Review question 11: Are driver information, education and training interventions effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

Six studies were included in the review. Overall the quality of the studies was poor with 5 studies graded [-] and 1 study graded [+] (see Table 3.2.3).

Studies were grouped by the intervention the study assessed:

- Driver information and training (4 studies)
- Anti-idling campaigns (2 studies)

Driver information and training

Barth (2009)[1] [-] modelled the effect of a dynamic eco-driving system where advice based on changing traffic speed, density and flow conditions is provided in real-time to drivers to reduce fuel use and so emissions.

Acceleration/deceleration events found in stop-go driving increase fuel consumption and emissions per unit distance. The overall goal of dynamic eco-driving is to smooth traffic flow by dynamically advising drivers to travel at specific speeds and to specify acceleration rates.

The authors used an algorithm to calculate the optimal speed for an individual vehicle based on its position and the road conditions at the time (speed, traffic flow and volume). This optimal speed is made known to the vehicle by wireless communications.

The authors determined the effectiveness of this dynamic eco-driving system by using simulations and real-world experiments. The authors note that eco-driving vehicles have much smoother velocity trajectories, resulting in lower fuel consumption and emissions with very little difference in overall travel time.

Table 6. Fuel consumption and travel times - simulations.

Velocity trajectory	Non-eco driving	Eco-driving	difference
Max (km/h)	80.5	48.9	-31.7
Min (km/h)	10.3	22.7	+12.4
Ave (km/h)	43.3	40.2	-3.05
Fuel consumption (g)	531.23	333.29	-37.3%
Travel time (min)	8.9	9.6	+7.7%

The authors note that overall traffic flow will be smoother if all vehicles use the technique (100% penetration rate). They note that even with 20% of the fleet using these rules overall traffic is smoother and fuel consumption is lower compared to baseline traffic.

The authors also carried out real-world experimentation. Real-time freeway traffic data from the PeMS system was used to compute a recommended speed for an eco-driving vehicle and transmitted to a dashboard display. The driver attempted to limit the vehicle speed to the recommended level. A control vehicle was operated along the same route in the same traffic without any recommended speed information. Several runs were carried out and an example with high levels of congestion presented. The authors note that the speed-acceleration histograms show fewer and milder accelerations.

Table 7. Fuel consumption and travel times for experimental runs.

Velocity trajectory	Non-eco driving	Eco-driving	difference
Max (km/h)	117.9	93.6	-24.3
Min (km/h)	0.00	0.00	0.0
Ave (km/h)	33.9	32.1	-1.9
Fuel consumption (g)	1766	1534	-13%
Travel time (min)	38.9	41.2	+6%

The authors note that overall, fuel consumption can be reduced by around 10-20% without drastically affecting travel time. The percentage savings depend on congestion: under free-flow conditions there is little benefit while there are considerable savings under severe congestion conditions.

Evidence statement 11.1: air pollution benefits from dynamic eco-driving

One [-] quality modelling study from the US[1] found that a 10-20% reduction in fuel consumption could be obtained by using wireless technology to inform drivers of the appropriate speed on major roads[15]. These saving could be achieved even if only small numbers (20%) of drivers participated, while they could be greater with greater participation. The savings are likely to be more significant in severe congestion conditions.

Applicability: This study is from the US and differences in road management systems and driver behaviour mean it is partially applicable.

1. Barth 2009 (−)

Caulfield (2014)[3] [-] assessed the impact of provision of real-time feedback on speeding and idling together with access to a website with feedback on fuel consumption. Four groups were given real time on-board feedback (speeding alerts, excessing manoeuvers when cornering and breaking, idling alerts and real-time fuel consumption information) and access to the web information on their emissions and suggestions to reduce them at different points in the study. One group received no information as a control. There were substantial differences in the age characteristics of the groups making meaningful comparisons difficult. Two groups (A and B) received on-board driver feedback for the duration of the trial and access to on-line information and suggestions about reducing emissions for the duration of the trial (group A) or for the last 4 months (group B). Group C received no intervention for 2 months followed by on-board feedback and access to online information. Group D received no intervention for 2 months followed by access to online information only. Information about changes in fuel consumption (CO_2/km) is given (presumably as kgCO_2/km, although this is not stated in the paper – no units for the values of CO_2 are given; they are however in the range that might be expected for KgCO_2/km for the vehicles used. The highest average level of CO_2/km was seen in the control group (0.1409kgCO_2/km), with levels in the other groups varying from 0.1308 kgCO_2/km (group D) to 0.1387 kgCO_2/km (group A). However, as noted above, there were considerable differences in the age make-up of the groups. The authors note that the effectiveness of the interventions can be looked at within groups C and D where an intervention started after 2 months of measurements with no intervention. They note that for group C a reduction of 8.85% was seen (following access to on-board feedback and online information), and for group D this was 10.3% (following access to online information only). However they also note that due to instrumentation problems this analysis was only carried out on 9 participants from group C and 7 from group D (out of 27 and 16 allocated to these groups respectively).

A before and after study in Canada (**Rutty (2013)[6]**) [-] looked at the impact of an ‘eco-driving’ course providing individualised feedback based on Feedback Intervention Theory focusing on gentle acceleration, keeping to speed limits, anticipation of traffic flow, coasting to slow down and reducing unnecessary idling. Participants were fleet drivers working for the City of Calgary carrying out a variety of

daily inspections, including electrical, plumbing, gas, buildings and compliance. Drivers used either a hybrid or gasoline (petrol) vehicle. Drivers in both groups reduced their average idling time (0.4 hrs/day for gasoline and 0.2 hrs/day for hybrid drivers), although total distance driven also decreased (from 40 to 38.1 for gasoline and 34.5 to 24.5 for hybrid vehicles). There were mixed results on behavioural measures, with reductions in hard decelerations in the gasoline group (0.2 counts per vehicle per day) while hard accelerations increased by 0.1 counts per vehicle per day. Hybrid drivers increased both hard decelerations and accelerations by 0.1 counts per day.

Campbell-Hall (2011)[2] [+] examined the context in which information, education and training interventions are effective at reducing the health impact of, or people's exposure to, traffic-related air pollution. The study examined views of training providers, 'stakeholders' (transport delivery bodies, road safety organisations, trade unions), drivers and employer on the take-up of post driving test 'Eco-driving' training. Key themes were:

- The low take up is related to the current economic climate and the high quality of the standard driving test
- Clear, specific emphasis on cost saving would help providers to sell eco-driving courses
- 'in-vehicle' training and pre/post training comparison of fuel consumption could encourage sustained behaviour change, particularly if coupled with systems to track fuel consumption
- 'eco-driving' as a term may be unhelpful compared to a focus on economic aspects
- Most drivers were aware of some of the relevant techniques but not the full range
- Main barriers to uptake were: cost of training, feeling that they were expert enough, doubts about sustainability of eco-driving practices and lack of evidence
- Main motivations for using eco-driving techniques were reduced fuel consumption and reduced wear and tear on vehicles

- Reducing CO2 emissions ranked low for most drivers but was more important for larger employers
- Motivations affecting uptake include: financial incentives, social norms, monitoring impact, corporate image and an element of fun
- In-vehicle training was viewed as the 'gold standard' and was felt to be appealing.

Evidence statement 11.2: Driver information and training

There was weak evidence from 1 [-] before and after study from Canada[6] and 1 [-] controlled study from the Netherlands[3] which suggests that feedback may have an effect in reducing CO_2 emissions/km driven or time spent with the engine idling.

The CT [-] from the Netherlands[3] assessed the impact of provision of real-time feedback on emissions of CO_2/km together with access to a website with feedback on emissions and ways to reduce them. Substantial differences in the age make-up of the groups render any meaningful comparison between groups difficult. Two groups received an intervention after 2 months of measurements with no intervention. This showed a reduction of 8.85% in kgCO_2/km following access to on-board feedback and online information, and of 10.3% following access to online information only. However this analysis was only carried out on 9 out of 27 and 7 out of 16 participants respectively.

The before and after study in Canada[6] looked at the impact of an 'eco-driving' course providing individualised feedback on driving style. Drivers of both hybrid and gasoline vehicles reduced their average idling time (0.4 hrs/day for gasoline and 0.2 hrs/day for hybrid drivers). Average daily distance driven also decreased, by 1.9km for gasoline vehicles and 10km for hybrid vehicles. There were mixed results, with reductions in hard decelerations in the gasoline group (0.2 counts per vehicle per day) but increased hard accelerations (0.1 counts per vehicle per day). Hybrid drivers increased both by 0.1 counts per day.

Applicability: These studies are from Canada and the Netherlands. Differences in climate in Calgary means that the study from Canada is partially applicable to England.

3. Caulfield el al. 2014 (−)

6. Rutty et al. 2013 (−)

Evidence statement 11.3: Barriers to uptake of driver training and information

There was weak evidence from 1 qualitative study[2] [+] that suggests that cost and lack of belief of potential benefit were key barriers to uptake of 'eco-drive' training beyond the standard driving test. Adding emphasis on the cost savings from such schemes, rather than environmental benefits, could increase their attractiveness. 'In-vehicle' training, coupled with systems to track fuel consumption and comparisons pre/post training were felt to be key.

Applicability: this study was carried out in the UK and so is applicable to England.

2. Campbell-Hall et al. 2011 (+)

Anti-idling campaigns

Eghbalnia (2013)[4] [-] examined interventions to reduce idling around 4 Cincinnati public schools at pick up and drop off. Bus drivers, staff and parents received interventions aimed at reducing the time spent with engines running while waiting to pick up or drop off students. Bus drivers were given a training video and presentation which highlighted the exposure to air pollution from idling and the potential impact on children and adults. They were asked to sign pledge forms to reduce time spent idling. Staff and parents received information via assemblies or information packages containing factsheets and pledge forms. Analysis looked at changes in number of vehicles at drop off and pick up times and the length of time they spent idling. For buses, time spent idling pre-intervention was 289 seconds at drop off and 397 seconds at pick up, falling to 116 seconds at drop off and 78 seconds at pick up. For parent vehicles drop off idling fell from 29 to 24 seconds and at pick up from 244 to 79 seconds. Number of vehicles at drop off and pick up also fell, from 61 to 41 and 35 to 28 respectively. No statistical analysis of these results is presented. Knowledge about idling was also assessed before and after the intervention; bus drivers

increased their score from 7.3/10 questions correctly answered to 8.5/10 ($p<0.05$) while the score for staff and parents increased from 2.5/4 to 3.6/4 ($p<0.05$).

A linked study by **Ryan (2013)[7]** [-] looked at air quality indices at the 4 schools and at an outdoor community monitoring site corresponding to the catchment area of the school. Average values over 5 days for $PM_{2.5}$ were calculated for the 9 hour period from 30 minutes before the arrival of the first bus in the morning until 30 minutes after the departure of the last bus. These were measured in the spring before the intervention and in the spring following it. The concentration of $PM_{2.5}$ at community sites ranged from 12.2 to 17.6 μg m^3 and at schools sites from 13.1 to 17.9 μg m^3. For $PM_{2.5}$, levels were higher at the school site than the community site for 3 schools (B, C and D). Levels decreased post intervention at both school and community sites at schools B and D and increased at A and C. The change in average school-background differences were significant for schools B (which had the highest number of buses picking up and dropping off) and D. Following the campaign, average difference in $PM_{2.5}$ levels between the school and the background at school B (with the most buses) decreased from 4.11μgm^{-3} to 0.99μgm^{-3} ($p < 0.05$).

Table 8. Average difference in $PM_{2.5}$, elemental carbon and between school and community sampling sites

	School											
	A			B			C			D		
	Pre	post	*p*	Pre	Post	*p*	Pre	Post	*p*	Pre	Post	*p*
$\Delta PM_{2.5}$	-0.95	-0.52	0.77	4.11	0.99	0.04	0.9	-4.71	0.33	0.48	-1.35	0.03
$\Delta PM_{2.5}$ in μg/m^3; -ve number indicates average concentration at background exceeds community concentration.												

The authors note that significant reductions in $PM_{2.5}$ and EC were seen at the school B with the largest number of buses (39) but that changes in air pollutants were not seen at schools with fewer buses (5-11).

Evidence statement 11.4: Anti-idling campaigns

There was weak evidence from 2 [-] linked before and after studies from the US[4,7] indicating a small positive effect from anti idling campaigns on time spent idling by school bus drivers and parents collecting or delivering children. Positive changes in

air quality measures were only seen where there were large numbers of school buses.

In 1 study[4] looking at the effect of training videos and information designed to reduce time spent idling, bus drivers reduced the time spent idling from 289 seconds at drop off and 397 seconds at pick up to 116 seconds at drop off and 78 seconds at pick up. Parents who receiving similar information reduced idling at drop off from 29 to 24 seconds and at pick up from 244 to 79 seconds. Number of vehicles at drop off and pick up also fell, from 61 to 41 and 35 to 28 respectively. A linked study[7] examined the impact on air pollution indices around the schools participating in the other study compared to 'community sites'. This found that results were mixed. Prior to the intervention, the concentrations of $PM_{2.5}$ at schools exceeded those of the community sites at 3 of the 4 schools, and was significantly greater at School B, the school with the highest number of buses (average difference 4.11 µg m-3, $p<0.01$).

Following the intervention, the average level of $PM_{2.5}$ at School B was the only location exceeding the background site (average difference 0.99 µg m-3, $p<0.01$). The change in average school-background differences were significant for Schools B (4.11 to 0.99µg/m^3) and D (0.48 to −1.35µg/m^3). In the case of School D, average community concentrations of $PM_{2.5}$ exceeded school concentrations after the anti-idling campaign.

Applicability: These studies are from the US where transport to school by school bus is more common than in England. However the intervention was also directed at parents and staff. The evidence is therefore partially applicable to England.

4. Eghbalnia et al. 2013 (−)

7. Ryan et al. 2013 (−)

4 Discussion

4.1 Strengths and limitations of the review

Overall, the quality of the evidence reviewed was poor. Nine studies scored [-] and only 1 study scored [+]. Studies relating to travel planning suffered from lack of reporting of some methods, for instance the process of randomisation. The context in which they occurred (such as the extent of previous attempts to discourage car use) are also important and make extrapolation to wider contexts difficult.

Studies on driver training were carried out with small groups and in some cases there were instrumentation problems which resulted in loss of participants.

These studies did not report air pollution outcomes directly. The main outcomes reported were either changes in fuel consumption or changes in driving style including reductions in idling time. While air pollution outcomes are more directly relevant to the topic, it is unrealistic to expect these to be identified in small studies of drivers. Driving style and fuel consumption are important factors in determining overall emissions from vehicles which in turn are important in determining air quality levels. Thus, while they need to be treated with caution, they are appropriate in considering impact on air quality.

Further detail of the strengths and weaknesses of individual studies can be found in the evidence tables (Appendix 1).

4.2 Applicability

The studies of workplace travel planning were from the UK and so are applicable. However, they are between 16 and 10 years old and site specific issues may be significant.

The study of individual travel planning is from Japan and so is likely to be partially applicable.

Studies on driver information were from the USA, Canada and the Netherlands and so are likely to be partially applicable.

Most of the reviewed studies were from outside the UK. While the types of approaches used in the studies (anti-idling campaigns and driver training) can be replicated in this country, specifics such as the use of school buses may be very different. Hence much of the evidence is of only limited applicability to the UK.

4.3 Gaps in the evidence

4.3.1 Review question 9: Are settings-based travel planning (such as in workplaces, new residential developments or schools) interventions effective and cost effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

We aimed to find evidence of the effectiveness of:

- Car sharing schemes
- car parking
- improved facilities to encourage cycling or other non-motorised travel
- cycle-to-work schemes
- policies relating to business travel, including using public transport rather than driving, or incentives for businesses to promote cycling at work
- management of vehicle movements related to business activities
- interest-free season ticket loans
- signage and cycle parking
- lighting and planting.

We found limited evidence relating to workplace travel planning which include a number of these interventions. However, we did not find any evidence relating to travel planning in other settings.

4.3.2 Review question 10: Are personalised travel planning interventions to support low emission travel choices effective and cost effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

We aimed to find evidence of the effectiveness of:

- Personalised travel planning to provide individuals with information, education, incentives and motivation to support low emission travel choices

One study was found from Japan.

4.3.3 Review question 11: Are driver information, education and training interventions effective at reducing the health impact of, or people's exposure to, traffic-related air pollution?

We aimed to find evidence of the effectiveness of driver information, education and training interventions on reducing the health impact or exposure to traffic-related air pollution.

Very little directly applicable evidence was found.

- No evidence of the effectiveness of driver training courses for the general public was found.

5 Included studies

1. Barth, Matthew, Boriboonsomsin, Kanok, Energy and Emissions Impacts of a Freeway-Based Dynamic Eco-driving System, Transportation Research: Part D: Transport and Environment, 14, 400-410, 2009

2. Campbell-Hall, V., Dalziel, D., Eco-driving: factors that determine take-up of post-test training research, 94, 2011

3. Caulfield, Brian, Brazil, William, Ni Fitzgerald, Kristian, Morton, Craig, Measuring the Success of Reducing Emissions Using an On-Board Eco-Driving Feedback Tool, Transportation Research: Part D: Transport and Environment, 32, 253-62, 2014

4. Eghbalnia, Cynthia, Sharkey, Ken, Garland-Porter, Denisha, Alam, Mohammad, Crumpton, Marilyn, Jones, Camille, Ryan, Patrick H., A Community-Based Participatory Research Partnership to Reduce Vehicle Idling Near Public Schools, Journal of Environmental Health, 75, 14-19, 2013

5. Nakayama,S, Takayama,J, Ecotravel Coordivator Program. Effects on travel behavior and environmental attitude, Transportation Research Record: Journal of the Transportation Research Board, 1924, 224-230, 2005

6. Rutty, Michelle, Matthews, Lindsay, Andrey, Jean, Matto, Tania Del, Eco-driver Training within the City of Calgary's Municipal Fleet: Monitoring the Impact, Transportation Research: Part D: Transport and Environment, 24, 44-51, 2013

7. Ryan, Patrick H., Reponen, Tiina, Simmons, Mark, Yermakov, Michael, Sharkey, Ken, Garland-Porter, Denisha, Eghbalnia, Cynthia, Grinshpun, Sergey A., The impact of an anti-idling campaign on outdoor air quality at 4 urban schools, Environmental science. Processes & impacts, 15, 2030-7, 2013

8. Sargeant,J, Carter,T, Mcsweeney,S, Hughes,W, Cambridgeshire Travel Choice Project. Final Report, -, 2004

9. Watts, E., Stephenson, R., Evaluating an employer transport plan: effects on travel behaviour of parking charges and associated measures introduced at the University of Sheffield., LOCAL ENVIRONMENT, 5, 435-450, 2000

10. *Macmillan, A. K., Hosking, J., Connor, J. L., Bullen, C., Ameratunga, S., A Cochrane systematic review of the effectiveness of organisational travel plans: Improving the evidence base for transport decisions, Transport Policy, 29, 249-256, 2013 (used for citation searching for review questions 9 and 10)*