PUBLIC HEALTH POLICY AND PRACTICE

What are the most effective ways of improving population health through transport interventions? Evidence from systematic reviews

D S Morrison, M Petticrew, H Thomson

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See end of article for authors' affiliations

Correspondence to: Dr D S Morrison, Greater Glasgow NHS Board, Homelessness Partnership, 1st floor, 32 Albion Street, Glasgow G1 1LH, UK; david.morrison@gch.glasgow.gov.uk

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Study objective: To review systematic review literature that describes the effectiveness of transport interventions in improving population health.
Methods: Systematic review methodology was used to evaluate published and unpublished systematic reviews in any language that described the measured health effects of any mode of transport intervention.
Main results: 28 systematic reviews were identified. The highest quality reviews indicate that the most effective transport interventions to improve health are health promotion campaigns (to prevent childhood injuries, to increase bicycle and motorcycle helmet use, and to promote children's car seat and seatbelt use), traffic calming, and specific legislation against drink driving. Driver improvement and education courses are associated with increases in crash involvement and violations.
Conclusions: Systematic reviews are able to provide evidence about effective ways of improving health through transport related interventions and also identify well intentioned but harmful interventions. Valuable additional information may exist in primary studies and systematic reviews have a role in evaluating and synthesising their findings.

Transport has the potential to affect health in a number of ways.[1–3] Health may be promoted by enabling access to work and social activities, including exercise, or it may be damaged through accidents, air and noise pollution, and other social[4] and environmental[5] impacts. Observational and experimental evidence is available to describe some of these mechanisms, for example, the effects of physical activity on obesity,[6] type 2 diabetes mellitus,[7] hypertension,[8] cardiovascular disease,[9] osteoporosis,[10] mental health, and some cancers.[11] But whether any transport policy or programme will actually cause changes in exercise related health depends upon a chain of events occurring and just because some links in the postulated chain can be demonstrated, it does not mean that the whole chain is proved.[12] At a population level the relation between transport and health is complex and sometimes counterintuitive. For example, an increase in traffic volume in the United Kingdom has been accompanied by a fall in serious and fatal road traffic accidents.[13] Compulsory cycling helmet legislation in Victoria, Australia, was followed by a fall in the severity and frequency of head injuries,[14] which may have been partly a result of a 36% reduction in cycling and its health benefits by children and teenagers.[15] In attempting to reduce inequalities through transport policies and programmes, it is worth noting that highly efficacious clinical interventions may be implemented in ways that worsen inequalities.[16] Thus, the health effects of transport interventions need to be evaluated in field trials so that these complex impacts can be assessed.

The aim of our review was to identify high quality evidence on the effects of transport policies and programmes on health. We restricted our search to literature describing population based interventions and their measured health impacts for the reasons given above. We did not restrict our search to specific diseases or potential risk factors. We sought evidence from systematic reviews for several reasons. The first is that few practitioners, and even fewer policymakers and planners, have the time, skills and other resources to review all the available evidence. Reading a systematic review is a more reasonable proposition and there is a growing recognition that syntheses of research results rather than results of single studies are needed.[17] Systematic reviews may play an important part in identifying effective social and policy interventions, as illustrated by international initiatives such as the Cochrane Collaboration (http://www.cochrane.org/default.html) and the Campbell Collaboration[18 19] and in the UK, the ESRC funded Evidence-based Policy and Practice Initiative (http://www.EvidenceNetwork.com/). The quality of evidence presented by rigorous systematic reviews is usually of a high standard because reviewers use methods that minimise selection, inclusion, and measurement biases.[20] And lastly,

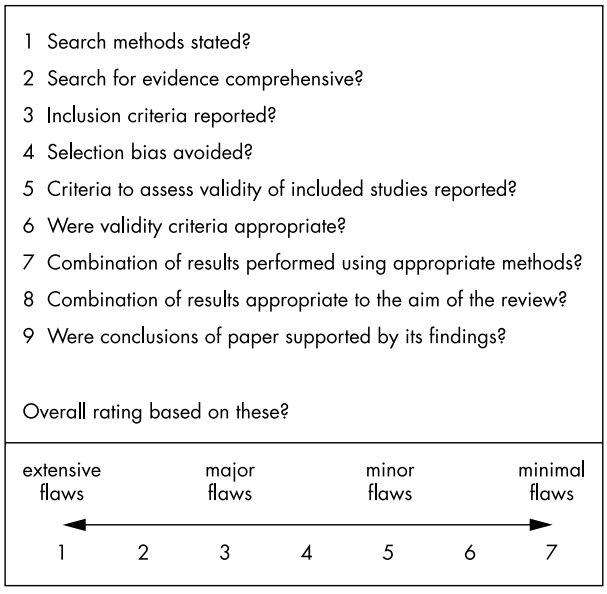

Figure 1 Criteria for evaluating overviews. Oxman and Guyatt.[21]

Table 1 Main findings of systematic reviews on health promotion interventions to improve health through transport

Modes of intervention	Quality Indices	Main results
Primary care based counselling to prevent childhood injury	4[23]	Injury prevention counselling as part of routine health supervision increased car seat and seat belt use, decreased motor vehicle occupant injuries and decreased hospital visits for traffic injuries.
	7[24]	School based and public/parent education to use bicycle helmets reduced hospital inpatient rates for bicycle injuries by up to 0.2% more than control group. Reductions in hospital admissions as a result of general injury prevention approaches showed 20% decrease in 1 study, but NS effects in other programmes.
Promotion of childhood rear car seats	6[25]	The evidence is weak that either educational campaigns or legislation to encourage front and rear seat belt use and placing children in rear seats are effective in changing behaviour. At some ages, there was a decrease in placing children in rear seats or in using rear seat belts. A number of included studies did not show statistically significant effects of the intervention.
Health promotion and community based approaches to reduce unintentional injury	5[26–28]	(<15 years old): Road environment modifications reduced accidents by 7–32%; package of engineering measures reduced accidental injuries by 25%; road safety education can reduce casualties from children emerging from behind a vehicle by 20%; cycle helmets associated with 48% and 70% reduction in hospital admissions and death, plus 23% and 28% reduction in non-head injuries over 2 year study period; child restraints and seatbelts reduced injury severity.
	7[29 30]	(15–25 years old): Bicycle and motorcycle helmets reduced head and other injuries and motorcycle helmet legislation was followed by a 30% reduction in fatalities, its repeal by an increase of 25–40% (the effect of reductions in cycling and motorcycling rates in the population is unclear); raising the minimum drinking age above 18 is associated with decrease in young driver and passenger fatalities. No proven effect of: training in reducing motorcycle injury; enhanced driver education courses; school-based programmes, rehabilitation for drink drivers, and education on the effects of catastrophic injury. Programmes that unintentionally enable adolescents to drive at a younger age than they would otherwise may have a negative effect.
Driver improvement and education programmes	3[31]	24/59 included programmes resulted in statistically significant reductions in violations (4–21%) but 3/59 resulted in significant increase in violations of 9, 14 and 40%. Crash reductions of 6–32% in 10/59 included programmes but 3/59 resulted in crash increases of 20, 30 and 46%. No proven effect of individual vs group interventions, direct vs indirect approaches or targeting certain types of violation.
	7[32]	RCTs show increase in crash involvement and violations as a result of high-school aged driver education courses. Ecological studies show both increases and decreases in crash involvement after driving education programmes and increases in licensure rates in 16–17 year olds.
Road safety campaigns	3[33]	Average campaign effect for all campaigns is 7.6% improvement. Persuasive rather than educative approaches are more effective. Legislation alone is not effective but requires enforcement plus publicity. Prior qualitative research, emotional vs rational appeal, theoretical model basis vs none, and specific behaviour request, increase the effectiveness of campaigns. Prevalence of baseline knowledge is inversely related to potential for impact of campaign.
	4[34]	All road safety campaigns show 7.0% reduction in accidents over and above the background temporal reduction in accident rates. Financial rewards are most effective, followed by enforcement + legislation combinations and in cities rather than rural settings.
Safety belt incentives	7[35]	Campaigns that use tangible incentives (such as money, prizes and vouchers) lead to substantial short-term increases in safety belt use (mean effect 12.0% increase above baseline) but have more modest longer term effects (mean effect 9.6% increase above baseline). Campaigns were most effective in elementary schools, where incentives were given immediately rather than delayed, and where the initial baseline use of seatbelts was low.
	6[36]	Educational campaigns: 1 found 5% increase in children in rear seats ($p<0.05$); 1 pilot programme found 30% increase in child restraint use in rear seats ($p<0.05$) in elementary schools, but other settings and placing children in rear seat were NS. Legislation requiring restraints when children were in front car seats had effects on the use of rear seats: 1 study found 19% increase; 1 study found 9% increase in <1 year olds, 2% in 1–4 year olds and decrease of 4% in 5–9 year olds but NS effects in 10–14 year olds; 2 studies found NS effects.
	7[37]	Child restraint use in rear seats: 3 studies found increases of 11–16% ($p<0.05$); 1 study found decrease in restraint use of 10% in 1–4 year olds and 3% in 5–9 year olds but increase in <1 year olds (all $p<0.05$). Community and clinical programmes to increase <5 year olds' car seat and seatbelt use have moderate but only short term effects. 3 RCTs showed 36% increase in car seat or seatbelt use.
Remediation of drinking and driving offenders	7[38]	RCTs of probation and rehabilitation to reduce alcohol consumption and injury-related sequelae showed improvements in motor vehicle crash risks (RR 0.76–0.90) and injuries (RR 0.47 and 0.58) but probation and rehabilitation together may increase risk of injury (RR 1.06 NS).
	3[39]	Programmes to treat drink drivers show non-alcohol related crashes were worse as a result of the intervention (mean 11% increase) but a small decrease in alcohol related crashes occurred (mean 7% reduction). More severe licence sanctions reduced crash rates by 1–7% but lighter sanctions increased crash rates by 7%.

RR, risk ratio; RCT, randomised controlled trial; NS, not significant at $p<0.05$ level.

systematic reviews indicate the principal areas in which evidence exists and may indicate gaps in knowledge.

METHODS

Inclusion criteria

We included all published and unpublished reports in all languages describing systematic reviews or meta-analyses of the effects of any mode of transport or transport policy on health. Health effects included social, psychological, and physical effects that could be measured on humans.

Exclusion criteria

We excluded non-systematic literature reviews, descriptions of environmental or physical effects that did not include human responses to them, behavioural interventions without objectively measured outcomes, predicted but not empirical health impacts, and reviews that described the effects of intermediate mechanisms by which transport affects health—such as exercise, walking or cycling—without evaluating the effectiveness of policies or programmes to bring about these changes.

Table 2 Main findings of systematic reviews on engineering interventions to improve health through transport

Modes of intervention	Quality Indices	Main results
Ignition interlock devices	4[40]	Ignition interlock devices were used for convicted drink-driving offenders. Re-arrest and re-conviction were reduced in intervention versus control groups (RR 0.36–0.85) in a variety of study designs, including an RCT.
Studded tyres	3[41]	Studded tyres may increase or decrease accident rates, depending on road conditions. 8 included studies found changes in accident rates significant at 95% level: on snow (18–72% reduction), on bare roads (increase of 151% to decrease of 68%), and on all road surfaces (16–57% reduction). Studies with higher quality (large size, surface condition of road specified, type of tyre specified, confounding variables accounted for) showed small, NS effect sizes (2–5% accident reductions). 5 studies on the effects of laws prohibiting the use of studded tyres found increases in accident rates of 3–10% ($p<0.05$).
Traffic calming schemes	6[42]	Traffic calming describes measures to discourage non-local traffic from using residential streets and reducing the speed of the remaining traffic. Area wide traffic calming reduces the number of accidents by a mean of 15% in the whole area affected by the measures (main roads and local roads combined). The effects are relatively constant in different countries and in different years.
Daytime running lights	4[43]	Daytime running lights are associated with a reduction in multi-party accident rates of 14–18% ($p<0.05$ in prospective controlled studies and in uncontrolled prospective designs, NS in RCTs). All types of accident (front/side impact, rearend collision, pedestrian, not specified) reduced by 14% (12–16%). There is no clear dose-response relation between proportion of cars using DRLs and accident rates. The effects of DRLs are greater with increasing latitude (for example, 9% reduction in accidents in Israel *v* 60% reduction in Finland).
Speed limit reductions	4[44]	Speed limit reductions may be effective on their own in reducing accidents but additional measures may be needed. Speed limit zones in built up areas reduce personal injuries but have no clear effect on material damage. Controlled studies show smaller reductions in personal injuries (18%, 8–26%) than uncontrolled studies (43%, 42–45%). Speed limit zones in quieter peripheral roads are effective in reducing both personal injuries (21%, 9–31%) and material damage (18%, 9–26%). A change to differential speed limits (slower in more built up areas, faster in peripheral roads) is associated with an increase in accidents in the peripheral areas (17%, 0–37%). For 30 km/h zones, accidents are reduced by 3.5% per km/h speed is reduced, independent of study design. Speed reduction by road humps shows non-significant reductions in personal injuries in controlled studies (37% reduction, 95% CI 67% reduction to 19% increase). Controlled studies show non-significant increases in accidents in areas surrounding road humps. Accidents are reduced by 4.5% per km/h speed is reduced, independent of study design. Raised crossroads are associated with non-significant increases in personal and material accidents. Rumble strips approaching crossroads are associated with significant decreases in personal (33%, 25–40%) and material (25%, 5–45%) accidents.

RR, risk ratio; RCT, randomised controlled trial; NS, not significant at $p<0.05$ level.

Search methods

We searched the following electronic databases plus the world wide web using www.Google.com: Ovid Medline (1966–1/2001), EMBASE (1980–1/2001), CINAHL (1982–1/2001), DARE (1/2001), ERIC (1966–1/2001), Cochrane Database of Systematic Reviews (2000, Issue 4) and PsycINFO (formerly PSYCLIT) (1971–1/2001) using the search terms meta-analys$, metaanalys$, systematic AND review, evaluation synthesis or research synthesis, limited to human subjects, where $ denotes all suffixes. Keywords were transport, car, cars, bus, automobile$, traffic or vehic$. TRANSPORT—which comprises the three databases TRIS, ITRD and TRANSDOC—was electronically searched from its first entries in the 1960s to February 2001 for all meta-analyses and systematic reviews without any additional restrictions on the initial search because all entries should be relevant to transport. Bibliographies of selected papers were searched and experts in the field were asked to identify other relevant reviews.

Evaluation of included reviews

Two reviewers independently screened abstracts then scored papers using Oxman and Guyatt's index for quality assessment of reviews,[21] using the nine criteria given in figure 1. A quality index, based on these criteria, could range from 1 (major flaws) to 7 (minimal flaws).

We have presented brief summaries of the most important findings of each review in the Results.

RESULTS

Altogether 3183 reports were identified in the first electronic search and all abstracts read to select those that met inclusion criteria. A total of 127 candidate papers and reports were selected. All were obtained and considered for suitability. Twenty papers were agreed to meet the inclusion criteria. A further eight eligible reviews were identified through contact with experts and bibliographies giving a total of 28 systematic reviews and meta-analyses. All reviews that appeared in the same special edition of the *American Journal of Preventive Medicine* were considered with an introductory paper[22] that described the common methodology of all their searches.

We classified reviews into four categories of intervention: health promotion, engineering, environmental, and legislative. Where reviews covered more than one type of intervention, the dominant area determined its classification in our summary. A brief summary of the results of each review is given in tables 1–4. Only six reviews, all of which described health promotion interventions, had minimal flaws.

Health promotion interventions

Systematic reviews with minimal flaws identified beneficial effects of primary care based counselling to prevent childhood injury and efforts to increase bicycle and motorcycle helmets,[24 29 30] and raising the minimum drinking age above 18 years.[29 30] Programmes to increase car seat and seatbelt use by children are effective but their benefits seem to be comparatively shortlived.[37] There are mixed effects of drink driving remediation, with some interventions, such as the combination of rehabilitation and probation, being associated with a potential increase in the risk of injury.[38] Driver improvement and education courses are associated with an increase in crash involvement and violations.[32]

Reviews with more methodological flaws, in addition to providing further information on topics already covered by better quality reviews, described beneficial effects of road safety and education campaigns.[26–28 33 34]

Table 3 Main findings of systematic reviews on environmental interventions to improve health through transport

Modes of intervention	Quality Indices	Main results
Public lighting	4[45 46]	Night time accidents were reduced by 15–35% as a result of public lighting interventions. The effect size was greater where more accidents occurred at night as compared with during the day. Fatal accidents reduced by 65% (range 52–75%) and property damage reduced by 17% (range 13–21%). The effects were also dependent upon the decade of study (greatest in the 1980s), the country of study (largest effect in Israel, smallest effect in Denmark), rural areas benefited more than urban environments, and pedestrians benefited more than other street users.
Guardrails and crash cushions	4[47]	Installing median barriers increases the total number of accidents by about 30% ($p<0.05$). Severity of accidents is reduced. New median barriers reduce the probability of fatal accidents by 32% (range 14–46%), given the total number of accidents, but apparently have no effect on the probability of injury accidents (–2%, –7–4% change). Guardrails reduce both the number of accidents (by 27%, range 18–35%) and their severity. Crash cushions reduce both number (84%, range 74–90%) and severity of accidents although studies are few and of doubtful validity.
Modifiable risk factors for child pedestrian injuries	3[48]	Child risk factors, in order of effect size, are age, behaviour, race, and sex. Social and cultural risk factors increasing likelihood of child pedestrian injuries are income (RR 5.7), crowding (RR 1.3 to 3.4), mother's working status and history of hospitalisation (RR 2–2.5), illness in the family (RR 2.3), and mother's education. Physical environment risk factors are, in descending order, volume of traffic, speed limit, predominant type of dwelling, absence of play area, location on road, protection of play area, proportion of curb side parking, street mean vehicle speed, shared driveway, type of road, time of day, weather, and lighting.

RR, risk ratio.

Engineering improvements

Five reviews were identified although four[40 41 43 44] had major methodological flaws (table 2). Elvik's review of traffic calming schemes[42] had a Quality Index of 6. It found that traffic calming schemes had a mean effect of reducing accidents by 15% and that similar effect sizes were found in different decades and in different countries.

There is some evidence from less methodologically rigorous reviews for the effects of ignition interlock devices, studded tyres, daytime running lights, and measures to reduce vehicle speeds. Ignition interlock devices, which require drivers to record a legal breath alcohol level before the car engine can be started, were associated with reductions in re-conviction and re-arrest rates for driving while intoxicated of at least a third.[40] Studded tyres had mixed effects, on some road surfaces increasing accident rates and in others reducing them.[41] Laws to enforce the use of studded tyres were associated with statistically significant increases in accident rates of 3%–10%. The use of sidelights or dipped headlights during the day (daytime running lights) was associated with reductions in accidents involving more than one vehicle of about 14%, but this effect was much greater in more northerly countries.[43] Speed limit zones are effective in reducing personal accidents and material damage.[44] Creating raised road surfaces at crossroads may increase accidents, while noisy road surfaces (rumble strips) before crossroads are associated with reductions in accidents. Road humps and differential speed limits may reduce accidents locally but increase them in surrounding areas.

Environmental interventions

Three reviews considered environmental interventions (table 3) and all had more than minor methodological flaws.

Elvik's review[45 46] found that public lighting reduced night time accidents in all cases but depended on the baseline risk and the proportion of night time accidents.[45] Guard rails and crash cushions were found to increase numbers of accidents but decrease their severity.[47] One review,[48] with a Quality Index of 3, aimed to describe the effects of modifiable risk factors on child pedestrian injuries. Age, behaviour, race, and sex were considered to be among the strongest risk factors although it is not clear how any but behaviour might be modified.

Legislative interventions

Six reviews considered the effectiveness of legislation on accidents, injuries, and drinking and driving (table 4). A review that had a quality score of 6 found that laws for a maximum legal blood alcohol concentration of 0.02% reduced night time injuries and fatal crashes.[51] The introduction of random breath alcohol testing is associated with a reduction in alcohol related hospital admissions, deaths, injuries, night time crashes, and charges for drink driving by around a fifth.[53] A review of laws against drink driving in the absence of any other offence ("administrative per se")[52] had minor flaws and found inconclusive results although no harmful effects. Other studies had more methodological flaws and their results should be interpreted with caution. Legislation to deter drinking and driving was effective in most cases although several studies on mandatory jail sentences showed increases in crashes after legislation.[49 50] Lighter sanctions against drink drivers increased subsequent crash rates by 7%[39] (see table 1). Foss[54] found that graduated driver licensing (where there is progressive freedom after passing the driving test to drive unaccompanied and at night) and night time curfews were associated with variable reductions in deaths and accidents. These were confounded to some extent by reductions in the rate of licensure among teenagers. Laws to enforce car seat belt use by adults increased belt use and reduced serious and fatal injuries.[55]

DISCUSSION

Evidence is available in well conducted systematic reviews both to support a range of transport related interventions that will benefit health and to indicate interventions that are intended to improve health but are in fact harmful and should not be implemented. Beneficial interventions include health promotion campaigns to prevent childhood injuries, efforts to increase bicycle and motorcycle helmet use, children's car seat and seatbelt promotion, traffic calming, and specific legislation against drink driving. Driver improvement and education courses may increase accidents by encouraging greater numbers of inexperienced drivers on to the roads. We agree with comments made in a review[56] published during the preparation of this paper that they cannot be recommended. Evidence for other health effects of transport interventions has also been identified in systematic reviews that have more methodological flaws. Ignition interlock devices, daytime running lights, public lighting, graduated driver licensing, and laws to enforce seatbelt use may all be effective in improving health. The evidence is equivocal on the benefits and harms of

Table 4 Main findings of systematic reviews on legislative interventions to improve health through transport

Modes of intervention	Quality Indices	Main results
Drinking and driving legislation, including administrative per se, random screening and lowering the legal blood alcohol limit	4[49 50]	A systematic review on drink driving control showed that licence suspension, illegal and administrative per se laws, selective and regular enforcement patrols and sobriety checkpoints were most effective, with typical effect sizes of around 10% reduction in a variety of outcomes. Several studies on mandatory jail sentences showed increases in crashes following implementation.
	6[51]	Laws requiring a reduction to maximum 0.02% blood alcohol concentration associated with reduction in night time injuries of 17% (NS); 12% reduction in injuries in men, 24% in women; 17% reduction in fatal crashes among younger drivers (p<0.001), 1% in older drivers; 22% net reduction in fatal crashes. Pre-post with interrupted time series (1 study): 4% reduction in serious injuries using time series, 6% reduction using pre-post – both NS. Interrupted time series (1 study): 11% or 33% reduction in "had been drinking" crashes depending on model chosen.
	5[52]	Evaluation of licence suspension or revocation through administrative determination showed no clear effect in 1/3; in 1/3, recidivism in intervention *v* controls OR 0.60 (0.54 to 0.68) up to but not after 36 months; in 1/3, intervention *v* controls in first year – drunk driving offences OR 0.78 (0.76 to 0.79), traffic crashes OR 0.65 (0.63 to 0.67) and alcohol related crashes OR 0.73 (0.70 to 0.77).
	6[53]	Random breath testing reduced hospital admissions by 20%, reduced deaths and injuries by 17–35%, reduced night-time crashes by 18–19% and reduced charges for drink driving. Checkpoints reduced night-time crash rates by 10–38% and reduced fatal crashes by 17–25%.
Graduated driver licensing among young drivers	4[54]	Graduated driver licensing was associated with a reduction in hospital admissions of up to 23% and a reduction in deaths of 5.5% in 15–19 year olds; however, there was a simultaneous reduction in 15–19 year olds who drove and a 5% decrease in the teenage population in New Zealand. A provisional licencing programme for 16–17 year olds showed a 5% decrease in daytime crashes; no effect of night time driving restriction; and a 10% decrease in traffic violation convictions. Curfew laws in under-18s: (1/4) found no apparent effects; (3/4) found decrease in fatality by 23–28%.
Car safety belt laws (only for adults)	3[55]	Prevalence of seat belt use increased by 1.08–1.3 times after laws introduced. Primary enforcement compared with no laws found 1.5–4.1 times more prevalent seat belt use (17 studies); one outlier of 15.4 times more use of seatbelts; RR fatal injury 0.69 to 0.97 (20 studies) but 1.12 (NS) in 1 study; serious non-fatal injury RR 0.20 to 0.89 (11 studies). Secondary enforcement compared to no laws found a prevalence of seatbelt use 2.1–2.6 times higher in the former group (6 studies); RR fatal injury 0.62 to 1.03 (7 studies), but no significant value over 1.00; serious non-fatal injury RR 0.75 to 0.85 (4 studies). Any law compared with no law: 4 studies found that relative risk of fatal injury was 0.91 to 0.95 in the former.

RR, risk ratio; OR, odds ratio; RCT, randomised controlled trial; NS, not significant at p<0.05 level.

guard rails, crash cushions, and interventions to reduce vehicle speeds. Some modes of drink driving remediation, including mandatory jail sentences and laws to enforce studded tyres, are associated with harmful effects on health. Further research, beginning with more rigorously conducted systematic reviews, is needed to determine whether these findings are valid.

The scope of this review

All 28 systematic reviews and meta-analyses on transport and health that we identified were concerned with injury prevention and all but four were concerned with preventing motorcar injuries. We did not use accident prevention as a primary search term because published and ongoing reviews exist in this area.[57–59] We found no evidence to suggest that any intervention will bring about a shift in the use of different modes of transport and as a result improve health in the broader ways suggested in the Introduction. Such evidence may exist in primary studies that have not been synthesised in systematic reviews. For those who support public policies to promote walking, cycling, and public transport, experimental evidence may be superfluous and the intrinsic value of reducing our dependence on the car may be self evident. But this review has identified several counterintuitive effects of apparently beneficial transport programmes. We therefore believe that evidence of outcomes should guide transport interventions that are intended to benefit health and that good intentions are not enough.

Information from qualitative and quantitative research that describes important relations between transport use and broader determinants of health, for example exercise[6] or severance of communities by roads[60] may be helpful both in designing more effective new interventions and in understanding how the social and environmental context of an intervention may influence its effectiveness. It was not our aim to review the entire body of literature on how transport affects health, however, but to identify where population based interventions have been shown to impact upon health.

Because of the loss of information in summarising reviews we would recommend that anyone considering using their findings obtains the original papers.

Quality of included reviews

Oxman and Guyatt's quality scores[21] for each study indicate that only six reviews achieved a score of 7, indicating minimal flaws. Six studies had a score of 3 or less, indicating major flaws. Failure to demonstrate that selection bias had been avoided and inappropriate assessment of validity were the commonest methodological problems overall. Oxman and Guyatt scores mark down failure to report review methods, even if they have been carried out. It is therefore important for systematic reviews to make their methodology explicit. Improvements in database search engines are also needed so that, for example, controlled trials can be more readily identified.[61]

One implication of these results is that systematic reviews and meta-analyses have a useful contribution to evidence based policymaking for transport. As evidence of the health effects of other interventions continues to accrue, regularly updated systematic reviews will be required. Some of this work may fall within the remit of the newly established Campbell Collaboration (http://campbell.gse.upenn.edu/).

Key points

- It may be possible to improve health by changing the way that people use different forms of transport.
- The evidence to support the actual effects of changing transport policies, plans, and programmes is often poorly described.
- Systematic reviews can provide accessible summaries of evidence on the effects of transport on health, using comprehensive search methods and explicit criteria for evaluating the quality of included primary studies.
- We found that health can be improved through health promotion campaigns, traffic calming schemes, and some legislation. But some interventions, such as driver improvement and education courses, may be harmful to health.
- The population health would be improved by implementing transport policies based on high quality research evidence and by withdrawing those where there is good evidence that any benefits are outweighed by harms.

Systematic reviews do not, however, obviate the need for high quality primary studies as important sources of evidence to improve health through transport choices.

Conclusions

Systematic reviews are able to provide evidence about effective ways of improving health through transport related interventions. The best evidence indicates that health promotion campaigns to prevent childhood injuries, increase bicycle and motorcycle helmet use, and children's car seat and seatbelt use, plus traffic calming, and specific legislation against drink driving are all beneficial, while driver improvement and education courses may be harmful. A systematic review of primary studies that embraces a wider range of possible health effects of transport—including social and environmental effects—is required and work on this is underway by the authors. This should determine if evidence is available to support claims for a spectrum of health effects, whether this evidence is of acceptable quality, and if not, where new primary studies should be directed. In the meantime, we suggest that policymakers, planners and health professionals put the available evidence into practice and monitor its benefits on health.

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Authors' affiliations

D S Morrison, Greater Glasgow NHS Board, Glasgow, UK
M Petticrew, H Thomson, MRC Social and Public Health Sciences Unit, Glasgow, UK

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