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TABLES | NOVEMBER 2011

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ABOUT THE NATIONAL COLLABORATING CENTRE FOR HEALTHY PUBLIC POLICY

The National Collaborating Centre for Healthy Public Policy (NCCHPP) seeks to increase the expertise of public health actors across Canada in healthy public policy through the development, sharing and use of knowledge. The NCCHPP is one of six Centres financed by the Public Health Agency of Canada. The six Centres form a network across Canada, each hosted by a different institution and each focusing on a specific topic linked to public health. In addition to the Centres' individual contributions, the network of Collaborating Centres provides focal points for the exchange and common production of knowledge relating to these topics.

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INTRODUCTION

The tables below constitute a synthesis of the evaluations of traffic-calming interventions included in our literature review, including our comments.[a] Readers will find here a synthesis of each study (research questions, methodology, results), along with a column containing remarks about the conceptual validity, the internal validity and/or the reliability of each one. Although they are presented individually, the studies are grouped into three broad intervention categories: those evaluating individual traffic-calming measures (when these are not explicitly identified as part of an area-wide intervention); those evaluating a series of measures installed on a single road; and those evaluating a series of measures in a geographic area including more than one road (whether they were planned to function in a systemic manner on a road network or were installed without an explicitly identified intervention logic[b]).

The studies are thus presented with the aim of achieving one general goal and two specific objectives. The general goal is to allow for a reading of the studies that is independent of our working proposition. In other words, the general idea is to allow the reader to structure and interpret the information differently from the way we have done so within the context of our literature review.

The first objective is to allow readers to grasp all the dimensions of a particular study that fall within one of the intervention categories. In reality, some evaluations examine several determinants of health at once (for example, air pollutant emissions and vehicle noise). However, since our literature review is organized according to determinants, the results from a given study can be distributed among different parts of the text. The format of the tables makes it possible to quickly perceive all the dimensions covered by a particular study.

The second objective is to allow readers to group the studies evaluating individual interventions and those evaluating area-wide interventions differently from the way we have done in the literature review. In our review, we have used the studies evaluating individual calming measures and those evaluating a series of measures installed on a single road to analyze the effects of the black-spots approach and the studies evaluating a series of measures implemented in a geographic area comprising more than one road to analyze the effects of the area-wide approach. However, as is explained in the introduction to the literature review, there exists no consensus as to the most appropriate way to classify interventions and evaluations involving a series of measures installed on a single road. Some authors treat them as individual interventions, and others, as area-wide interventions. Thus, the tables are intended to assist readers in grouping these interventions alternatively and in drawing their own conclusions.

[a] To read the literature review, see "Urban Traffic Calming and Health: A Literature Review" at: http://www.ncchpp.ca/docs/ReviewLiteratureTrafficCalming_En.pdf

[b] It is arguable whether studies evaluating a series of measures contained within a given geographic area should be treated in the same manner as studies evaluating area-wide interventions when the intervention logic of the former has not been specified. To allow readers to interpret the information differently, an explanatory note has been included in the "Remarks" column to clearly identify such studies.

1 EVALUATIONS OF INDIVIDUAL TRAFFIC-CALMING MEASURES

AUTHOR (YEAR)	**RESEARCH QUESTION**[1]	**METHODOLOGY**	**RESULTS**[2]	**REMARKS**[3]
(Abbott, Tyler, & Layfield, 1995)	How do maximum noise levels emitted by different types of vehicles on different types of roads maintained in different conditions vary? What effects do traffic-calming measures that vertically deflect vehicles have on traffic noise levels?	Design: experimental before-after study. Road types simulated in the London Transport Research Laboratory (U.K.) with narrow and wide speed cushions, speed humps, poorly-maintained and level roads. Vehicles tested: light (cars and milk trucks), buses and heavy vehicles (from 16 to 38 t). Maximum noise level measured at 7.5 m from road centre and at 1.2 m from ground (at a constant speed of 25 km/h and at constant speeds based on typical average speeds before and after installation of the traffic-calming measures tested) and modelling of sound levels (based on seven traffic composition scenarios).	Maximum vehicle noise level: At a constant speed of 25 km/h, the implementation of traffic-calming measures on a level roadway leads to fewer increases in maximum noise levels (in dB L_{Amax}) than road deterioration, for all types of vehicles. At typical constant speeds before and after the installation of traffic-calming measures, the introduction of vertical deflections has the following effect: reduces the average maximum noise level for light vehicles (-10.2 to -6.6^{Ŧ} dB L_{Amax}); slightly increases (+1.0^{Ŧ} dB L_{Amax} for narrow speed cushions) or lowers (-3.6 to -0.5^{Ŧ} dB L_{Amax} for others) that of buses; increases that of heavy vehicles (+2.0 to +7.9^{Ŧ} dB L_{Amax}), except in the presence of round-top humps (-2.1^{Ŧ} dB L_{Amax}). Noise levels: Depending on the composition of traffic, the introduction of vertical deflections has the following effect on ambient noise conditions: improves it when there are only light vehicles (-7.1 to -4.8 dB $L_{Aeq}{}^{Ŧ}$); improves it, has no effect, or worsens it (-1.3 to +7 dB $L_{Aeq}{}^{Ŧ}$) when there are 10% heavy vehicles and 1% buses; worsens it (+0.1 to +8.7 dB $L_{Aeq}{}^{Ŧ}$) when there are 1% buses and 25% heavy vehicles. Narrow speed cushions and	Experimental fleet of heavy vehicles noisier than the average fleet in the country (overestimation of noise). Noise measurements based on typical constant speeds for each type of traffic-calming measure instead of taking into account speed variations caused by traffic-calming measures (risk of overestimating noise from suspension systems and rattling metal while underestimating acceleration and deceleration noise). No statistical significance test mentioned.

[1] The question or questions listed here are not necessarily isomorphic with those of the evaluations. When a study examined a broader subject than that of traffic calming, for example, the relationship between the built environment and physical activity, we formulated the questions such that they pertain to traffic calming.

[2] In general, when statistical significance tests are mentioned in the studies, only the significant results are reported here. Systematically, the term "significant," as well as the "*" symbol are used to identify significant results of at least *p* <0.05. When non-significant results are reported, they are identified by the term "non-significant," as well as by the absence of the "*" symbol. Results for which studies mention no statistical significance test are identified by the "Ŧ" symbol, and a comment is included in the "Remarks" column.

[3] The remarks included in this column concern the internal validity of the study and its reliability. Considerations related to external validity generally concern all the studies and are therefore addressed in the conclusion of the literature review.

EVALUATIONS OF INDIVIDUAL TRAFFIC-CALMING MEASURES (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Abbott, Tyler, & Layfield, 1995) (cont.)			round-top humps would be preferable where heavy vehicles are present, because they would allow for decreased noise levels even in the presence of 94% cars, 1% buses and 5% heavy vehicles for narrow speed cushions, and of 79% cars, 20% heavy vehicles and 1% buses for round-top humps.	
(Boulter & Webster, 1997)	What are the effects of various traffic-calming measures and strategies on the emission of air pollutants by motor vehicles?	Design: traditional literature review. Data from 12 case studies (seven different countries) are reported and the interventions are briefly described. One case study concerns an intervention at a single point on a road network, six case studies examine the effects of introducing a series of measures on a road and five case studies concern area-wide interventions.	Effects on gas-powered cars of an intervention at a single point on a road network: • Speed hump, car with catalytic converter (WCC): +20%[Ŧ] Carbon monoxides (CO), +4%[Ŧ] Carbon dioxide (CO_2)/gas, +18%[Ŧ] Nitrogen oxides (NO_x) ; • Speed hump, car with no catalytic converter (NCC): +11%[Ŧ] CO, +5%[Ŧ] CO_2/gas, +22%[Ŧ] NO_x.	The methodology used to locate the case studies is not described. No statistical significance test mentioned.
(Campolieti & Bertoni, 2009)	What are the effects of replacing traffic lights with a roundabout on ambient noise levels in Modena (Italy)?	Design: before-after. Noise levels recorded by microphones located at three sites (two at the roundabout and one a few dozen metres away on a street leading to it).	Reduction of 1[Ŧ] dB L_{Aday} and of 2.5[Ŧ] L_{Anight}.	Controlled for volume and composition of motor traffic. Tables and calculations are somewhat obscure: data that would be needed to reproduce calculations on which conclusions are based are missing. No statistical significance test mentioned.

EVALUATIONS OF INDIVIDUAL TRAFFIC-CALMING MEASURES (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Gibbard et al., 2004)	What are the effects on space sharing by motor vehicles, cyclists and pedestrians of traffic-calming measures that narrow roads at specific points and of measures for assisting cyclists at these points?	Design: (1) Internet survey, (2) before-after and after-only. (1) Survey by questionnaire between July 10, 2002 and August 13, 2002. Administered through the websites of cyclists' associations, so respondents were relatively experienced cyclists (n=393). (2) Analysis of conflicts between motor vehicles and cyclists at five sites where centre islands (raised medians) had been installed to provide a safe crossing point for pedestrians. A before-after study for two sites and after-only for the other three. Data on: number of cyclists; number of conflicts; whether or not motor vehicles slowed down; where vehicles overtook cyclists in relation to the road narrowing; distance between vehicles and cyclists; distance of cyclists from the curb. Sites with varying characteristics (for example, presence or absence of bike lane; regular bike lane vs. lane painted green). Daytime video survey (12 hours) for two days after (in all cases) and two days before (in two cases). Control for speed and volume of traffic.	(1) 78.4% of respondents indicated that the traffic-calming measures were problematic (because, according to them, they encourage motor vehicles to travel closer to cyclists); 17% said they were unaffected; 3.8% said the measures helped them. From among a list of phenomena resulting in road narrowings (various traffic-calming measures, parked vehicles, bus stops, etc.), respondents selected pedestrian refuge islands or raised medians (38.9%), as well as chicanes (8.9%) as problematic. Over 40% of respondents said they stopped at a road narrowing, 46.8% said they sometimes move onto the sidewalk at narrowings, and 48.6% indicated they sometimes choose another route to avoid narrowings. A few cyclists (5.3%) indicated feeling stressed or intimidated when negotiating this type of traffic-calming measure in the presence of motorcycles, but this percentage climbs to 33.6% when cars are present, 46.6% for buses, 59.8% for light vans, and 61.6% for medium or heavy trucks. Women indicated feeling more stressed or intimidated than men. (2) Cyclists appear to have a tendency to move closer to the curb when they are overtaken near a pedestrian island. The presence of a mandatory bike lane, without facilities allowing cyclists to bypass the narrowing, seems to encourage motor vehicle drivers to travel closer to cyclists. The presence of warning signs indicating an approaching island seems to prompt	(1) Experienced cyclists; mainly male (15.5% women, 84.5% men). (2) Two of the sites were part of area-wide schemes, although they were evaluated in isolation; the number of cyclists and conflicts observed was too low to produce statistically significant results.

EVALUATIONS OF INDIVIDUAL TRAFFIC-CALMING MEASURES (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Gibbard et al., 2004) (cont.)			drivers to overtake cyclists before the island and to leave less space between themselves and cyclists when overtaking– except when the bike lane is painted green, which seems to prompt drivers to overtake cyclists after the island and to leave more room between their vehicles and cyclists. In areas where traffic was heavier and/or vehicles were sometimes parked along the edge of the road, cyclists tend to travel further from the curb as they pass through the road narrowing and drivers are less likely to overtake cyclists before or while passing through the narrowing.	
(Mountain, Hirst, & Maher, 2005)	What is the average effect of various speed management measures (speed cameras; vertical deflections; horizontal deflections and road narrowings and speed-activated signs) on collision frequency and vehicle speeds?	Design: before-after with control sites (empirical Bayes method: change in safety = expected number of collisions vs. number recorded). 79 sites with speed cameras; 31 sites using one or several horizontal deflections, road narrowings, speed activated signs (n=4) or speed limit painted on asphalt (n=1); 39 sites using vertical deflections (or a combination of vertical and horizontal deflections). Data from police and other local authorities on collisions, personal injury collisions (PICs) and collisions with persons killed or seriously injured (KSI). Data for 3 years before and, on average, 2.5 years after. Speed cameras: collisions recorded within a	Vertical deflections are more effective (-44%*, confidence interval [CI] 95%: -54 to -34) than horizontal deflections (-29%*, CI 95%: -48 to -8) and speed cameras (-22%*, CI 95%: -30 to -13) for reducing collisions. These reductions appear to correspond to reductions in average speed (vertical: -13.5 km/h*, CI 95%: -16.6 to -10.5; horizontal: -5.3 km/h*, CI 95%: -7.1 to -3.7; speed camera: -6.6 km/h*, CI 95%: -7.6 to -5.5). For KSI collisions, only vertical deflections produced significant reductions (-35%*, CI 95%: -54 to -18), whereas horizontal deflections (-14%, CI 95%: -44 to +32) and speed cameras (-11%, CI 95%: -26 to +6) produced non-significant reductions. For speed cameras and vertical deflections, respectively, -6%* (CI 95%: -9 to -3) and -6%* (CI 95%: -10 to -3) collisions are due to reduced traffic volume.	The grouping together of horizontal deflections and road narrowings with speed-activated signs (n=4) and markings indicating the speed limit (n=1) is unusual. The authors specify that they were grouped together because their results were similar. The inclusion of sites using vertical and horizontal deflections with sites using vertical deflections may obscure the specific effects of the combination. The analyses include control for regression to the mean only for total collisions. The article does not describe the implementation contexts of the traffic-calming measures evaluated. It is therefore impossible to

EVALUATIONS OF INDIVIDUAL TRAFFIC-CALMING MEASURES (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Mountain, Hirst, & Maher, 2005) (cont.)		distance of 1 km upstream and 1 km downstream from the cameras.	Children, as cyclists and as pedestrians, as well as pedestrians, appear to benefit most from vertical and horizontal deflections. (The reductions concerning them are significant, but the results presented by type of road user do not take into account either regression to the mean or the underlying trend.) As regards the number of PICs avoided and not the percentage of reduction, speed cameras installed on high-volume roads registering a higher number of PICs allow for the avoidance of as many injuries (-1.00*/km/year, CI 95%: -1.4 to -0.6) as vertical deflections (-1.03*/km/year, CI 95%: -1.4 to -0.8) usually installed on local roads with lower traffic volume.	determine whether some of them were planned and implemented so as to function in a systemic manner within a road network.
(Retting, Bhagwant, Garder, & Lord, 2001)	What are the nature and the extent of reductions in collisions and their severity following the installation of modern roundabouts in the United States?	Design: before-after with control sites (empirical Bayes method: change in safety = expected number of collisions vs. number recorded). Analysis of data from police reports or, when these were unavailable, from report summaries concerning 24 modern roundabouts.	Reduction of 38%* in the total number of collisions (TCs), of 76%* in personal injury collisions (PICs) and of 89%* in fatal and incapacitating injury collisions (FIICs). Single-lane roundabout, in an urban environment, replacing stop signs: -61%* (TCs) and -77%* (PICs). Similar results in rural environments: -58%* (TCs) and -82%* (PICs). Multi-lane roundabouts, in an urban environment, replacing stop signs: -5% (TCs). Single-lane roundabout, in an urban environment, replacing traffic lights: -35%* (TCs) and -74%* (PICs).	Explanatory mechanism: reduced speeds and decrease in conflict points.

EVALUATIONS OF INDIVIDUAL TRAFFIC-CALMING MEASURES (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Stout, Pawlovich, Souleyrette, & Carriquiry, 2006)	What are the effects on road safety of road diets (reduction from four to three lanes on bidirectional roads)? Do the two analysis methods used produce similar results?	Design: before-after with control sites and empirical Bayes method (change in safety = expected number of collisions vs. number recorded). Two methods using the same 15 experimental sites and 15 control sites: (1) Empirical Bayes Method. Analysis of monthly data from the Iowa Department of Transportation, for 23 years. (2) Before (5 years)-after (5 years) study with control sites.	(1) Reduction of 25.2%[Ŧ] in the number of collisions per kilometre (collision density) and of 18.8%[Ŧ] in the collision rate (controlled for volume) at the experimental sites, as compared to the control sites. (2) Reduction of 28%[Ŧ] in the number of collisions per kilometre (collision density), of 21%[Ŧ] in the collision rate (controlled for volume), of 34%[Ŧ] for injury collisions, of 11%[Ŧ] for fatal and serious collisions, of 30%[Ŧ] for minor injury collisions and of 31%[Ŧ] for possible injury collisions.	The expression "possible injury collisions" refers to collisions following which victims complained of pain, but where no other symptoms were visible. No statistical significance test mentioned.
(Tester, Rutherford, Wald, & Rutherford, 2004)	How does living on a street block with a speed hump installed affect the probability that a child will be injured or killed by a car when walking close to home?	Design: observational case-control study. Use of admission data for a hospital emergency department in the city of Oakland (U.S.A.) over a period of five years (1995-2000). Identification of persons aged under 15 years (n=100) living on local streets who had been admitted after being struck by a car while walking near their home (radius of 0.4 km). Excluded were injuries caused by cars backing out of a driveway or a parking space. Each case patient was matched with two control children (admitted on the	Among control children, 23% (n=46) lived near a speed hump, whereas among case children, the rate was 14% (n=14). The matched-pairs analysis indicated that the probability that a child living near a speed hump will be injured by a car near home (radius of 0.4 km) and admitted to hospital is significantly lower (odds ratio [OR][4] : 0.50*, CI 95%: 0.27 to 0.89) than that of children not living near this kind of traffic-calming measure. When the analysis considers only those children injured on the street block where they live (n=49), the protective effect of speed humps is even greater (OR: 0.38*, CI 95%: 0.15 to 0.90).	The protective effect of speed humps within a radius of 0.4 km may depend on the proximity of other traffic-calming measures installed in the sector. However, the article does not indicate the implementation contexts of the speed humps studied. It is therefore impossible to determine whether some of them were planned and implemented so as to function in a systemic manner within a road network.

[4] OR or odds ratio: An odds ratio is a statistic produced through logistic regression that expresses the relationship between the probability that an event will occur and the probability that it will not occur. An odds ratio can be used to determine if, all other things being equal, persons living in an environment defined by certain characteristics are more or less likely to move around by bicycle, for example. An odds ratio of 1 would indicate that the characteristic had no effect, whereas a ratio of less than 1 would indicate that the characteristic in question lowers the likelihood that such persons would move around by bicycle and a ratio of more than 1 would indicate an increase in the likelihood. The further the odds ratio is from 1, the greater the effect on the probability of the event occurring.

EVALUATIONS OF INDIVIDUAL TRAFFIC-CALMING MEASURES (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Tester, Rutherford, Wald, & Rutherford, 2004) (cont.)		same day for other medical reasons, matched in terms of gender and age and also living on a local street). Case children and control children were classified into two categories: those living on a street block with at least one speed hump installed and those living on a street block without any speed humps. Matched-pairs analysis to determine whether proximity of speed humps is a significant risk reduction factor. Univariate analyses to determine whether other variables (race, ethnicity, household income and medical insurance) are also significantly associated. Multivariate analysis to isolate the effect of speed humps.	Univariate analyses indicated significant associations for the variables of ethnicity and race. The multivariate analysis (adjusted for ethnicity and race) indicated that the protection provided by proximity to a speed hump remains statistically significant and similar for children injured within a radius of 0.4 km (OR: 0.47*, CI 95%: 0.24 to 0.95), however, although the point estimate still indicates a protective effect, the confidence intervals indicate that the relationship is no longer statistically significant for children injured on the street block where they live (OR: 0.40, CI 95%: 0.15 to 1.06). On the basis of these results, the article concludes that speed humps make the environment safer for children walking.	

2 EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED ON ONE ROAD

AUTHOR (YEAR)	**RESEARCH QUESTION**[1]	**METHODOLOGY**	**RESULTS**[2]	**REMARKS**[3]
(Ahn & Rakha, 2009)	What are the energy and environmental impacts of certain traffic-calming measures?	Design: before-after and cross-sectional. Study of behaviour on road network (and not on an experimental track) comparing: (1) at the intersections of a road: different traffic-calming measures (mini-roundabouts, speed humps, speed cushions), uncontrolled intersections and an intersection with stop signs; (2) on two other road sections: before and after the installation of five speed cushions on one road and two speed bumps on another. Combination of second-by-second GPS data (to capture variations in real speed) and microscopic energy and emission models. Different types of vehicles.	(1) Intersections with traffic-calming measures are associated with significantly greater gas consumption and higher emission levels than uncontrolled intersections and with significantly less consumption and lower emission levels than intersections with stop signs. (2) Traffic-calming measures significantly raise gas consumption and emission levels because they lead to variations in speed.	Data were collected on weekends to minimize interaction with other vehicles. (1) In comparisons of the traffic-calming measures at intersections, variations in emission levels on cross streets were not taken into account.

[1] The question or questions listed here are not necessarily isomorphic with those of the evaluations. When a study examined a broader subject than that of traffic calming, for example, the relationship between the built environment and physical activity, we formulated the questions such that they pertain to traffic calming.

[2] In general, when statistical significance tests are mentioned in the studies, only the significant results are reported here. Systematically, the term "significant," as well as the "*" symbol are used to identify significant results of at least $p < 0.05$. When non-significant results are reported, they are identified by the term "non-significant," as well as by the absence of the "*" symbol. Results for which studies mention no statistical significance test are identified by the "‡" symbol, and a comment is included in the "Remarks" column.

[3] The remarks included in this column concern the internal validity of the study and its reliability. Considerations related to external validity generally concern all the studies and are therefore addressed in the conclusion of the literature review.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED ON ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Boulter & Webster, 1997)	What are the effects of various traffic-calming measures and strategies on the emission of air pollutants by motor vehicles.	Design: traditional literature review. Data from 12 case studies (seven different countries) are reported and the interventions are briefly described. One case study concerns an intervention at a single point on a road network, six case studies examine the effects of introducing a series of measures on a road and five case studies concern area-wide interventions.	Effects on gas-powered cars of a series of traffic-calming measures on a road: • <u>Speed humps (SHs) with and without catalytic converter (CC)</u>: +70 to +80%Ŧ Carbon monoxides (CO), +70 to +100%Ŧ Hydrocarbons (HC), +50 to +60%Ŧ Carbon dioxide (CO_2)/gas, -20 to 0%Ŧ Nitrogen oxides (NO_x); • <u>Ten SHs with CC</u>: +300%Ŧ CO, +37%Ŧ CO_2/gas, +300%Ŧ NO_x; • <u>Ten SHs without CC</u>: +200%Ŧ CO, +51%Ŧ CO_2/gas, +300%Ŧ NO_x; • <u>Various traffic-calming measures and 40-km/h speed limit</u>: -9%Ŧ CO_2/gas; • <u>Six SHs with CC</u>: +300%Ŧ CO, +25%Ŧ CO_2/gas, +1000%Ŧ NO_x; • <u>Five SHs</u>: +36 to +73%Ŧ CO_2/gas; • <u>Two roundabouts</u>: +33%Ŧ CO_2/gas.	The methodology used to locate the case studies is not described. No statistical significance test mentioned.
(Boulter et al., 2001)	What are the effects of various traffic-calming measures (75 mm flat-top speed hump; 80 mm round-top speed hump; 100 mm raised intersection; 1.9 m and 1.7 m wide speed cushions;	Design: before-after and cross-sectional. <u>Emissions</u>: Evaluation based on the modelling of typical driving cycles before and after installation of traffic-calming measures on existing roads. Exceptions: for chicane, curb extension, mini-roundabout and speed cushions the data for modelling driving cycles before the interventions was taken from other roads with	<u>Emissions</u>: Average variations for all the traffic-calming measures taken together: Gas-powered cars NCC: +34%* CO, +50%* HC, +1% NO_x, +20%* CO_2; Gas-powered cars WCC: +59%* CO, +54%* HC, +8% NO_x, +26%* CO_2; Diesel-powered car: +39%* CO, +48%* HC, +28%* NO_x, +26%* CO_2, +30%* Particulate matter (PM). <u>Air quality</u>: 1998: +0.9 to +8.0%Ŧ CO,	The method used to model the typical speed profiles is not always made clear. For purposes of readability, steps that do not contribute to the final results because they were discarded and replaced by other procedures during the course of the experiment are not mentioned in the present document. The emission measurements based on the before and after speed profiles

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED ON ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Boulter et al., 2001) (cont.)	chicane; curb extension; combination of bollards for narrowing a road and a speed cushion; mini-roundabout) on the emission of air pollutants by motor vehicles? What are the expected effects of these emissions on ambient air quality?	similar characteristics. Combinations of radar-type instruments to record drivers' speeds without their knowledge, counters to record traffic volume and video cameras to determine the composition of motor traffic on the selected road sections. Composition of sample speed profiles on the road sections under study and modelling of typical driving cycles. Measurement on a chassis dynamometer of emissions for three categories of cars as they drove through each of the typical driving cycles (12 gas-powered cars used, including 2 small cars with catalytic converters [WCC], 2 small cars with no catalytic converters [NCC], 2 medium cars WCC, 2 medium cars NCC, 2 large cars WCC, 2 large cars NCC and 3 medium diesel-powered cars). <u>Air quality</u>: Compiled emission data were analyzed using a dispersion model to determine effects at 10 m from road centres. The results take into consideration decreased traffic volume at one site and increases at four sites after installation (but the report does not specify when). The results also take into account the traffic volume of heavy vehicles, the emission data for which are taken from a previous study focused on the	+1.4 to +11.9%[Ŧ] benzene, +2.9 to +11.2%[Ŧ] 1,3-butadiene, -1.2 to +5.1%[Ŧ] NO_2; 2000: +0.4 to +6.7%[Ŧ] CO, +2.7 to +10.1%[Ŧ] benzene, +2.7 to +9.5%[Ŧ] 1,3-butadiene, -0.4 to +4.3%[Ŧ] NO_2; 2005: -0.5 to +5.1%[Ŧ] CO, +1.2 to +7.7%[Ŧ] benzene, +1.2 to +7.2%[Ŧ] 1,3-butadiene, +0.5 to +3.3%[Ŧ] NO_2.	were not performed on the same cars. Seven of the twelve cars were replaced by other cars in the same category for the after tests. The results concerning air quality must be interpreted with caution because: (1) the report does not indicate when the before-after counts were taken. The authors imply that seasonal differences characterizing the before and after results or a general trend toward an increase in motorized travel can explain the increased traffic volume at four sites following the interventions. (2) No statistical significance test mentioned.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED ON ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Boulter et al., 2001) (cont.)		relationship between the speed of these vehicles and their emissions. The effect is estimated for three years (1998, 2000 and 2005), based on the estimated proportion of vehicles with and without catalytic converters in England, but not based on the evolution of traffic volumes.		
(Daham et al., 2005)	What effect do speed humps have on the emission of air pollutants?	Design: experimental, aimed at simulating before-after measurements. Measurements made using a device installed on the automobile. On-road measurements of emissions were made on an existing road with an average of seven speed cushions/km. Control runs were made on the calmed road at a constant speed of 50 km/h. Experimental runs were made to simulate the presence of 80 mm speed humps (the highest); specifically, the vehicle was slowed down to 16 km/h and accelerated back up to 32-50 km/h in second gear at each speed cushion. Drive cycles tested: 1.1 km, roundtrip = 2.2 km, 14 speed cushions.	Substantial increase in emission of all pollutants measured: +90%[Ŧ] CO_2; +117%[Ŧ] CO; +195%[Ŧ] NO_x; +148%[Ŧ] HC.	It would not be cautious to use these results to characterize present or future emissions of air pollutants by vehicles travelling over speed humps or speed cushions because: (1) use of an exceptional driving style (the most aggressive) and presence of aggravating conditions (e.g., vehicles were very heavy due to the measurement equipment; vehicles were slowed down more than is necessary to simulate comfortably travelling over speed humps); (2) control runs on road with speed cushions instead of on road without calming measures and test runs over speed cushions instead of over speed humps; (3) no statistical significance test mentioned.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED ON ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Morrison, Thomson, & Petticrew, 2004)	What are the effects on physical and mental health of the installation of several traffic-calming measures (five pairs of speed cushions, two zebra crossings, and parking bays) on the main road running through a disadvantaged residential area in Glasgow, UK?	Design: before (6 months)–after (6 months). Cohort of 750 participants recruited by random sampling (244 responded before and 185 after) to fill in postal questionnaires about their transport habits, their state of physical and mental health (SF-36 version 2), their perception of the neighbourhood, and of traffic problems and road safety. Two full-day pedestrian counts at three locations, with a one-year interval.	Significant increase in pedestrian activity. Perception: Significant reduction in traffic-related problems (e.g., parents allowing children to walk, cycle or play alone outside more, and less bothered by the speed of vehicles, fumes, noise, vibrations, etc. (refer to full table on p. 838 of the article). Significant improvement in self-reported state of physical health (note: no significant difference between those who reported walking more and the others). No significant effect on mental health.	Weak response rate (39% for the first questionnaire, once undelivered envelopes were taken into account, (244/624) and 32% for the second (185/576). The authors did not ask respondents if they had been unaffected or if they were walking or cycling less. The results of the pedestrian counts are congruent with the responses to the questionnaires with regard to physical activity, but these results are based solely on two one-day counts. The inclement weather for walking during the second count may have led to an underestimation of the increase in pedestrian activity.
(Watkins, 2000)	What are the effects of an intervention comprising several measures (curb extensions, raised pedestrian crossing, raised intersection and chicane) on a street in Cambridge, Massachusetts (USA)? How do residents perceive the impact on safety of an	Design: before-after and survey sent by post after. Measurement of percentage of drivers yielding to pedestrians before-after at a raised crossing and raised intersection. Survey by postal questionnaire between six and nine months after completion of construction work (perception of safety for various users of the street).	Drivers yielding to pedestrians: Raised crossing: 13% before, 53% after[‡]. Raised intersection: 18% before, 54% after[‡]. Perception of road safety: 69% better, 15% worse, 4% no change, 8% don't know. For pedestrians: 57% better and 13% worse. For cyclists: 33% better and 8% worse. For motorists: 46% better and 10% worse.	No statistical significance test mentioned.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED ON ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Watkins, 2000) (cont.)	intervention comprising several measures (curb extensions, raised pedestrian crossing, raised intersection and improved crosswalk markings for pedestrians) replacing a traffic light.			

3 EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD

AUTHOR (YEAR)	**RESEARCH QUESTION**[1]	**METHODOLOGY**	**RESULTS**[2]	**REMARKS**[3]
(Boulter & Webster, 1997)	What are the effects of various traffic-calming measures and strategies on the emission of air pollutants by motor vehicles.	Design: traditional literature review. Data from 12 case studies (seven different countries) are reported and the interventions are briefly described. One case study concerns an intervention at a single point on a road network, six case studies examine the effects of introducing a series of measures on one road and five case studies concern area-wide interventions.	Effects of area-wide interventions on gas-powered cars: • <u>Area with extensive traffic calming, without catalytic converter (CC)</u>: +7 to +71%ǂ Carbon monoxides (CO), -25 to -10%ǂ Hydrocarbons (HC), +7 to +19%ǂ Carbon dioxide (CO_2)/gas, -60 to -38%ǂ Nitrogen oxides (NO_x); • <u>30-km/h zone, without CC</u>: -20 to +28%ǂ CO, -23 to +2%ǂ HC, -6 to +14%ǂ CO_2/gas, -31 to -5%ǂ NO_x; • <u>Speed humps scheme</u>: Slight increaseǂ CO, no changeǂ HC, decreaseǂ NO_x; • <u>Area with extensive traffic calming</u>: Increaseǂ CO, increaseǂ HC, decreaseǂ NO_x; • <u>21 mini-roundabouts and 30-km/h limit</u>[4]: +2%ǂ CO, +<1%ǂ CO_2/gas, +1%ǂ NO_x.	The methodology used to locate the case studies is not described. No statistical significance test mentioned.

1 The question or questions listed here are not necessarily isomorphic with those of the evaluations. When a study examined a broader subject than that of traffic calming, for example, the relationship between the built environment and physical activity, we formulated the questions such that they pertain to traffic calming.

2 In general, when statistical significance tests are mentioned in the studies, only the significant results are reported here. Systematically, the term “significant,” as well as the “*” symbol are used to identify significant results of at least p <0.05. When non-significant results are reported, they are identified by the term “non-significant,” as well as by the absence of the “*” symbol. Results for which studies mention no statistical significance test are identified by the “ǂ” symbol, and a comment is included in the “Remarks” column.

3 The remarks included in this column concern the internal validity of the study and its reliability. Considerations related to external validity generally concern all the studies and are therefore addressed in the conclusion of the literature review.

4 Boulter and Webster (1997) classify this study among those evaluating cases of a series of calming measures installed on one road. However, the reference is to an evaluation of an area-wide scheme involving the installation of 21 mini-roundabouts in Växjö, Sweden, also evaluated by Hyden and Várhelyi (2000) and Várhelyi (2002). For this reason the study is included in this section.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Bunn et al., 2003)	Can area-wide interventions reduce road collision-related deaths and injuries?	Design: systematic review with meta-analysis. Inclusion of randomized trials and controlled before-after studies. Results pertain to 12 distinct controlled before-after studies evaluating a total of 16 area-wide strategies. Data collected from police or from “local authorities” on the number of collisions, fatal collisions and personal injury collisions. For each intervention evaluated, rate ratios were calculated for before/after/control zones.	<u>Fatal collisions</u>: Rate ratio (before/after/control zones): 0.63 (confidence interval [CI] 95%: 0.14 to 2.59) or -37% (CI 95%: -86 to +159). <u>Personal injury collisions (fatal and non-fatal)</u>: 0.89 (CI 95%: 0.80 to 1.00) or -11% (CI 95%: -20 to 0). <u>Collisions</u>: 0.95 (CI 95%: 0.81 to 1.11) or -5% (CI 95%: -19 to +11). <u>Collisions involving a pedestrian</u>: 1.00 (CI 95%: 0.84 to 1.18) or identical to the situation prior to the intervention (CI 95%: -16 to +18%).	The rates indicate a trend toward improvement, but the confidence intervals (CI) indicate that they are not statistically significant. Groups together evaluations of highly diverse area-wide interventions, which are only very briefly described (only the types of measures). The tests of heterogeneity between the results of different studies frequently proved statistically significant. A random effects model that pooled results was used to account for this heterogeneity. All the studies included focus on interventions carried out in the 1970s and 1980s. Having not controlled for exposure to risk, the authors suggest that there may possibly be more pedestrians in the calmed zones and that this would partially explain the absence of a reduction in collisions involving a pedestrian.
(Bunn et al., 2009)	Can area-wide interventions reduce road collision-related deaths and injuries?	Design: systematic review with meta-analysis. Update of the 2003 meta-analysis (Bunn et al., 2003): inclusion criteria modified to include “reduced speed limit zones.” Results pertain to 18 distinct controlled before-after studies evaluating a total of 22 area-	Fatal collisions: Rate ratio (before/after/control zones): 0.79 (confidence interval [CI] 95%: 0.23 to 2.68) or -21% (CI 95%: -77 to +168). Personal injury collisions (fatal and non-fatal): 0.85* (CI 95%: 0.75 to 0.96) or -15%* (CI 95%: -25 to -4).	Same remarks as for 2003, except that the confidence intervals (CI) indicate that the reduction in personal injury collisions is statistically significant. The dates of the added interventions are not indicated.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Bunn et al., 2009) (cont.)		wide strategies.	Collisions: 0.89 (CI 95%: 0.76 to 1.05) or -11% (CI 95%: -24 to +5). Collisions involving a pedestrian: 1.01 (CI 95%: 0.88 to 1.16) or +1% (CI 95%: -12 to +16).	
(Carver, Timperio, & Crawford, 2008)	What is the relationship between traffic-calming measures and active transportation for youth in Melbourne? What is the relationship between traffic-calming measures and physical activity for youth in Melbourne?	Design: cross-sectional study. Recruitment from 19 state primary schools in Melbourne (Australia) in areas of varying socioeconomic status (SES). Transport habits of young children (aged 5–6 years; n=295) reported by parents and self-reported by adolescents (aged 10–12 years; n=919). Moderate or vigorous physical activity outside of school hours recorded using accelerometers. Features of the road environment within a radius of 800 m around the home of each participant were identified using a geographic information system (GIS). Multiple regression analyses.	Adolescent boys in neighbourhoods with an average number of speed humps (from 2 to 7) are significantly less likely than those in neighbourhoods with a low number of speed humps (from 0 to 1) to make seven or more walking/cycling trips per week (odds ratio [OR]: 0.38*, confidence interval [CI] 95%: 0.15 to 0.97). However, adolescent girls in neighbourhoods with the most speed humps (from 8 to 99) are significantly more likely to make seven or more walking/cycling trips per week (OR: 2.95*, CI 95%: 1.34 to 6.51). The number of speed humps is significantly and positively associated with moderate to vigorous physical activity for adolescent boys during evenings (r=0.210*), but negatively with activity before school hours for adolescent girls (r=-0.073*). The number of road narrowings is significantly and negatively associated with physical activity for adolescent boys during weekends (r=-5.197*).	No significant association between the road environment and the likelihood of young children (aged 5–6 years) making seven or more walking/cycling trips per week. No significant association between the presence of traffic-calming measures and physical activity for young children. The article does not take into consideration the proximity of other features such as parks and businesses. In seeking associations between the road environment and seven or more walking/cycling trips per week, the authors may have missed other factors associated with fewer trips. This article evaluates the effects of traffic-calming measures on an area including more than one road, but it does not indicate whether or not the measures were planned and implemented so as to function in a systemic manner.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Cloke et al., 1999)	What are the effects of an area-wide strategy on collisions and injuries, on air quality and on noise? How are residents' perceptions affected? What are the effects on transport habits?	Design: before-after and before-after with control site. Evaluation of a traffic-calming scheme comprising various measures (raised intersection, speed cushions, pedestrian refuges, raised medians, curb extensions, mini-roundabouts, raised pedestrian crossings, gateways) aimed at reducing the speed of vehicles and at discouraging through traffic on residential streets in the Leigh Park area of Havant (UK). <u>Collisions</u>: Data for two 3-year periods before and for 20 months after. <u>Air</u>: For emissions, experimental analysis of driving cycles and modelling of HC, CO and NO_x. For air quality, diffusion tubes at six sites (including two control sites) to measure NO_2 and benzene. <u>Noise</u>: Analysis of noise levels (L_{Amax}, $L_{A10,\ 6h}$, $L_{A10,\ 18h}$, $L_{A90,\ 6h}$, $L_{A90,\ 18h}$) using the Statistical Pass-By method near three calming measures and residences. Video to determine vehicle types. <u>Perceptions and transport habits</u>: Interviews before and after of groups of residents selected among zones within the area to link results to the various measures.	<u>Collisions and injuries</u>: The number of personal injury collisions is stable 3 years before and 20 months after. No observable change involving motorcyclists, cyclists, and adult pedestrians, but a decrease of 50%[ŧ] per year in personal injury collisions involving child pedestrians. Air: Increase in emissions for most vehicles, but decrease for the area (due to the decrease in traffic volume). Non-significant improvement in air quality. Noise: In general, decrease in maximum noise level (L_{Amax}) of cars and increase in maximum noise level of heavy vehicles. Overall decrease in noise level exceeded 10% of the time during the day (-4.7 to -1.9[ŧ] dB $L_{A10,\ 18h}$) and at night (-3.6 to -0.1[ŧ] dB $L_{A10,\ 6h}$), except for noise at night at a pedestrian refuge (+2,6[ŧ] dB $L_{A10,\ 18h}$). Mixed results with regard to background noise (L_{A90}) during the day and significant increase at night (+7.8 to +14.1[ŧ] dB $L_{A90,\ 6h}$), but doubtful validity. Perceptions: Perceptions vary from zone to zone. In general, significantly fewer persons bothered by speeding vehicles, the amount of traffic, danger or difficulty in crossing the road, or danger to children. Perceived improvement in road safety. Little effect on perception of other dimensions documented (noise, air pollution, etc.). <u>Travel habits</u>: No notable effect.	<u>Air</u>: No statistical test related to emissions is mentioned. Wide margin of error for instrument used to measure air quality. The measurements from the control sites neutralize the results. <u>Noise</u>: The results are based on only two days and two nights of recording. No control for weather variation. It is noted that the second night was very windy, which could explain the increase in background noise recorded. <u>Perceptions</u>: Significant methodological imprecision (the report does not specify how the interviews were carried out or how participants were chosen). The results are based on the responses of 151 residents before and 150 after, of which only 113 did both before and after interviews. These results should be interpreted with reserve.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Elvik, 2001)	What are the effects of area-wide schemes on road safety?	Design: systematic review with meta-analysis. Review of 33 studies (1971–1994) that provide information about numbers of collisions. Data on: design (all are before-after studies, with or without control sites–heterogeneity test of effects over time and across location [several countries] and of publication bias); traffic volumes; types of roads; personal injury collisions; number of collisions; property damage only collisions.	<u>For the entire calmed area</u>: -15%* (confidence interval [CI] 95%: -17 to -12) personal injury collisions; -16%* (CI 95%: -19 to -13) collisions without injury. <u>For local roads in the calmed area</u>: -24%* (CI 95%: -29 to -18) personal injury collisions; -29%* (CI 95%: -25 to -22) collisions without injury. <u>For main roads in the calmed area</u>: -8%* (CI 95%: -12 to -5) personal injury collisions; -11%* (CI 95%: -16 to -6) collisions without injury. Retaining only the studies with the most robust designs (before-after with control sites) recording personal injury collisions, only the reductions for the entire calmed area (-12%*, CI 95%: -21 to -1) are statistically significant.	The results of the studies are relatively consistent across decades and countries, which seems to indicate that the reported effectiveness is not the result of confounding factors, as these would have had to influence results in a consistent and uniform manner in varying implementation and evaluation contexts.
(Forsyth, Hearst, Oakes, & Schmitz, 2008)	What is the relationship between walking and physical activity and certain characteristics of the built environment, including traffic-calming measures?	Design: cross-sectional study. Multilevel regression analysis to discern associations between over 200 environmental variables divided into four categories (density; street pattern or connectivity; pedestrian infrastructure and amenities [including calming measures]; and destinations) and walking and physical activity. Sample of 36 zones of 805 m x 805 m in Minneapolis-	Significant positive association between the percentage of calmed roads in an area (as well as the presence of sidewalks, street lights and several indicators of street connectivity) and both total walking distances (r=0.3674*) and transportation walking distances (r=0.3629*) covered by its residents, but no significant association with physical activity in general or leisure walking.	The concept of traffic-calming was operationalized in a restrictive manner that includes certain measures that can slow down motorized traffic. Excluded are measures acting on traffic volume and some that can influence speed by narrowing roads, such as bike lanes (Macbeth, 1998) (see online operationalization protocol www.designforhealth.net/pdfs/GIS_Protocols/NEAT_GIS_V5_0_26Nov2010FIN.pdf). Activity recorded from April to

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Forsyth, Hearst, Oakes, & Schmitz, 2008) (cont.)		St. Paul (USA) randomly selected among strata formed from pairings of median block size (small, medium, large) and residential density (low, medium, high). Random sampling of 715 participants, divided almost equally among the zones. Questionnaire focused on socioeconomic characteristics. Accelerometer and self-reported travel/walking diary. Environmental features measured through surveys and variables based on Geographic Information System (GIS) data from existing databases, interpretation of photos taken from satellites and a field-based urban design inventory.		November only. This article evaluates the effects of traffic-calming measures on an area including more than one road, but it does not indicate whether or not the measures were planned and implemented so as to function in a systemic manner.
(Grundy, Steinbach, Edwards, Wilkinson, & Green, 2008a)	What are the effects on inequalities in road traffic injuries of the 399 20-mph (32-km/h) zones in London (UK)? Note: In 2008, the percentage of roads covered by the zones varied by quintile (from 2.5% for Q1 [the	Design: longitudinal and cross-sectional study. Inequalities measured: Five levels of socioeconomic status (SES) based on the Index of Multiple Deprivation 2004 (data for 1987–2006) and on “ethnicity,” that is, white, black and Asian (data for 1996–2006). Personal injury collisions: Geocoded police data. Time series for intervention zones and adjacent areas. Calculation of the difference between the predicted	<u>London-wide</u>: Annual reductions were significantly greater in less-deprived SES quintiles for: personal injury collisions (PICs); child PICs; pedestrian PICs; cyclist PICs; powered two wheeler PICs; and car occupant PICs. Annual reductions were significantly greater among those identified as white than among Asian or black people for: PICs; child PICs; collisions with persons killed or seriously injured (KSI); pedestrian PICs; child pedestrian PICs; cyclist PICs; powered two wheeler PICs; and car occupant PICs. On the basis of a less	Controlled for the underlying downward trend in road injuries. Controlled for regression to the mean. Not controlled for underlying trend in road injury inequalities among ethnic groups; these results are therefore less reliable. The comparison among zones installed in areas with different SES was based on effectiveness expressed as a percentage, as is standard practice in the literature on this subject; it was not based on the number of injuries, of serious injuries,

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Grundy, Steinbach, Edwards, Wilkinson, & Green, 2008a) (cont.)	least deprived] to 27.5% for Q5 [the most deprived]). In 2000 coverage was less than 2% for all quintiles. In terms of zones, 6% of zones were in Q1 and 35% in Q5 in 2008, whereas in 1995, 40% were located in Q1 and 10% in Q5.	outcome without intervention and the situation recorded in 2006. Thus, a longer or shorter time after the intervention, depending on the zone.	conservative risk reduction factor than that used in 2009 (Grundy et al., 2009), the authors conclude that having targeted deprived areas for installation of 20-mph (32-km/h) zones can be viewed as having prevented 1,193 persons from being injured each year, with almost half of these being in the most deprived quintile. Regarding the number of injuries avoided, the installation of these zones can be viewed as having reduced the widening gap between PICs in the least deprived and the most deprived quintiles by about 15%‡. <u>Across 20-mph (32-km/h) zones</u>: Annual reductions (expressed as percentages) in PICs and KSI collisions are similar for zones and adjacent areas with varying SES, with the exception of powered two wheeler PICs and car occupant PICs, for which reductions are significantly higher in sectors adjacent to the most deprived areas. Annual reductions in PICs and KSI collisions in the zones and adjacent areas are similar for different ethnic groups. However, in calmed zones, significantly less reduction in KSI collisions, in pedestrian PICs and in child pedestrian PICs is observed among those identified in the study as black people than is seen among those identified as Asian or white.	and of deaths avoided. This practice is not without consequence for the results, for there are often more collisions, injuries and deaths in deprived areas than in the least deprived areas (Laflamme, Hasselberg, & Burrows, 2010; Cubbin & Smith, 2002; Morency & Cloutier, 2005). Thus, it is likely that interventions whose effectiveness, expressed as a percentage, is the same for areas with different SES would prevent more collisions, injuries and deaths if they were implemented in areas with a lower SES. Use of a less conservative hypothesis than in 2009 (Grundy et al., 2009) to assess the number of injuries avoided.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Grundy, Steinbach, Edwards, Wilkinson, & Green, 2008b)	What are the effects on the number and seriousness of collisions of the 399 20-mph (32-km/h) zones that have been installed in London (UK) gradually since 1990?	Design: longitudinal and cross-sectional study. Description of interventions assisted by use of a geographic information system (GIS). Calmed zones range from a road segment of 0.07 km to one of 37 km (median: 3.6 km). Quantification of the effects of each zone on collisions and risk of injury (data collected by police) within the zones, on adjacent roads, and outside areas to verify whether collision "migration" occurred. Annual rates over 20-year period (1986–2006) used in main analyses. Time series analysis used to check for regression to the mean. Individual analysis of zones and pooled results. Calculation of the difference between the predicted outcome without intervention and the situation recorded in 2006 (thus, a longer or shorter time after the intervention, depending on the zone).	<u>General trend in London</u>: From over 50,000 (1987) personal injury collisions to a little over 30,000 (2006), with a plateau from 1993 to 2001. <u>Pooled data from zones</u>: Total collisions -37.5%* (confidence interval [CI] 95%: -43.4 to -31.6); personal injury collisions (PICs); -41.9%* (CI 95%: -47.8 to -36.0%); PICs involving children -48.5%* (CI 95%: -55.0 to -41.9); collisions with persons killed or seriously injured (KSI); -46.3%* (CI 95%: -54.1 to -38.6); KSI collisions involving children -50.2%* (CI 95%: -63.2 to -37.2); pedestrian PICs -32.4%* (CI 95%: -37.7 to -27.1); child pedestrian PICs -46.2%* (CI 95%: -55.5 to -36.8); pedestrian KSI -4.8%* (CI 95%: -47.5 to -22.1); child pedestrian KSI -43.9%* (CI 95%: -61.3 to -26.6); cyclist PICs -16.9%* (CI 95%: -29.0 to -4.8); cyclist KSI -37.6%* (CI 95%: -60.9 to -14.4); powered two wheeler PICs -32.6%* (CI 95%: -43.4 to -21.7); powered two wheeler KSI -39.1%* (CI 95%: -59.1 to -19.0); car occupant[5] PICs -52.5%* (IC 95%: -62.4 to -42.5); car occupant KSI -61.8%* (CI 95%: -71.7 to -52.0). <u>Adjacent areas</u>: All collisions -7.4%* (CI 95%: -11.0 to -3.8); PICs -8.0%* (CI 95%: -11.5 to -4.4); KSI collisions -7.9%* (CI 95%: -13.5 to -2.2); car	There appears to be no significant difference between the large calmed zones (more than 3.6 km of road) and the small calmed zones (3.6 km and less) as regards the effectiveness of reducing personal injury collisions and collisions with persons killed or seriously injured. Having not controlled for exposure to risk in their analyses, the authors suggest that there may possibly be more pedestrians in the calmed zones and that this would partially explain the smaller reduction in collisions involving pedestrians. No migration of collisions was observed, but the results do not take into account measures that may have been taken to calm traffic on adjacent roads. Thus, the authors may overestimate the effectiveness of 20-mph (32-km/h) zones in reducing collisions on these roads. Data one year before and one year after presented in the body of the text, but up to five years before and five years after included in appendices (note: little difference between the two).

5 Occupants include drivers and passengers of automobiles.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Grundy, Steinbach, Edwards, Wilkinson, & Green, 2008b) (cont.)			occupant PICs -11.5%* (CI 95%: -16.5 to -6.4).	
(Grundy et al., 2009)	What are the effects of 399 20-mph (32-km/h) zones on the number of collisions causing minor injury, serious injury and death in London (UK)?	Design: longitudinal and cross-sectional study. Observational study of geocoded police data (1986–2006) covering 119,029 road segments with at least one collision (out of a total of 298,644 segments included in the database). Estimation of the effects in the area where the zones where introduced and on adjacent areas and adjustment for underlying downward trend.	Condensed form of the 2008 report; thus, results are the same (Grundy et al., 2008b). Result added for personal injury collisions involving child cyclists (0–15 years): -27%* (confidence interval [CI] 95%: -49.1 to -6.3). On the basis of a more conservative risk reduction factor than that used in 2008 (Grundy et al., 2008a), the authors estimate that the 20-mph (32-km/h) zones in London prevent 203 persons, including 51 pedestrians from being injured each year, and that, of these, 27 would have been seriously injured or killed.	Controlled for regression to the mean: little effect. Controlled for location of zones (city centre vs. periphery): no effect.
(Hemsing & Forbes, 2000)	What do residents and road users perceive to be the effects of traffic-calming measures on walking and cycling safety, on air quality, and on noise levels in	Design: survey and interview afterward. Survey by questionnaire. Comments from public during public hearings. Interviews with individuals, organizations and special interest groups. Results were pooled according to the categories of calmed roads	<u>Perception of air quality</u>: The majority of respondents observed no change or did not know if there had been one. For most road categories, more respondents perceived an improvement than deterioration. <u>Perception of environmental noise levels</u>: The majority of respondents observed no change or did not know if there had been	Non-random survey. Thus, there is a risk that it may not be representative of "the population" of Ottawa. On some roads, only a few surveys were filled out. No statistical significance test mentioned. The extrapolation of the results should therefore be interpreted with caution.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Hemsing & Forbes, 2000) (cont.)	Ottawa[6]? Have residents been walking and cycling more since the interventions?	(local, collector, regional) and the type of traffic-calming measures installed (vertical, horizontal, vertical and horizontal).	one. For most road categories, more respondents perceived an increase in noise levels than a decrease. Perception of pedestrian and cyclist safety: Overall, more residents perceived an increase in pedestrian safety and a decrease in cyclist safety. Travel habits: In general, residents did not think they had changed their habits.	
(Hyden & Várhelyi, 2000)	What are the effects of an experimental scheme involving the installation of 21 mini-roundabouts (at intersections whose daily volume can go as high as 23,500 vehicles) in Växjö, Sweden, on the risk of personal injury collisions, on yielding, on CO and NO_x emissions and on	Design: before-after. Several measurements before (four months) and after (four months for all and a follow-up four years later for four of the 21 mini-roundabouts). Measurements of speed, conflicts (at 12 intersections), videotapes, road user counts, interviews with pedestrians. Note: The calculation of emissions is discussed in detail in Várhelyi (2002). The same results are reported.	Conflict study: Stable total, car-car increase, car-bicycle and car-pedestrian decrease. Less serious conflicts (from frontal to angular and at lower speeds). Estimated number of personal injury collisions: -44%[Ŧ] (cyclists: -60%[Ŧ], pedestrians: -80%[Ŧ], drivers: +12%[Ŧ]). Note: one of the mini-roundabouts produced an increase in the risk of personal injury collisions of +200%[Ŧ] at one intersection. At a four-year follow-up, one mini-roundabout, whose centre island had been enlarged, was found to have complicated the route of cyclists. Yielding: More respect for the priority of other drivers (70% before and 91% after)[Ŧ], of cyclists (13% before and 77% after)[Ŧ] and of pedestrians (24% before and 51% after)[Ŧ].	The article points to the importance of design in the construction of traffic-calming measures and in the evaluation of effects (one of the mini-roundabouts, whose construction differed from that of the other mini-roundabouts included in this comparison study, was found to have increased the risk of personal injury collisions by about 200%[Ŧ]). The anomaly represented by this roundabout also reduced the positive effects on conflicts. The very small number of pedestrians questioned regarding their perception of the ease of crossing makes it necessary to interpret these results with caution.

[6] The report covers numerous other dimensions that could very well have been the subject of our literature review, such as the perceived effects of traffic calming on social cohesion, for example. However, this is the only study we found that examines these other dimensions. Given that the results concerning these dimensions are not in themselves conclusive, we decided not to review them. As regards air quality, environmental noise levels, and transport habits, there exists a body of literature which, although not very extensive, is at least sufficiently large to allow for analysis. This is why we have included these dimensions in the literature review.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Hyden & Várhelyi, 2000) (cont.)	noise levels? What was the perceived effect on ease of crossing for pedestrians?		<u>Emissions</u>: See Várhelyi (2002). <u>Noise</u>: Reduction of $3.9^{Ŧ}$, $4.2^{Ŧ}$ and $1.6^{Ŧ}$ dB L_{Aeq} for the three intersections studied. <u>Perception</u>: Of the 26 pedestrians questioned four years later, 40% found that crossing was easier at mini-roundabouts than at other intersections and 20% found it more difficult.	
(Jones, Lyons, John, & Palmer, 2005)	Does the distribution of traffic-calming measures reflect social and economic inequalities? Are they related to personal injury collision rates for child pedestrians?	Design: Ecological study of small area of intervention (two cities in the UK). Longitudinal analysis of injury rates with cross-sectional control for modes of travel to school. Participants: Sampling of children aged 4 to 16 years old between 1992 and 2000. Indicators: Distribution of interventions/socioeconomic status of areas and changes in personal injury collision rates/1000 residents (police data).	City A: Areas in the most deprived fourth had 4.8* (confidence interval [CI] 95%: 3.71 to 6.22) times the number of traffic-calming measures/1000 residents as those in the most affluent fourth. The personal injury collision rate for the whole city decreased from 6.98 to 4.84 between 1992–1994 and 1998–2000, which corresponds to a significant decrease of 2.14* (CI 95%: -2.81 to -1.48). In the most affluent areas, the rate went from 9.53 to 5.85, which corresponds to a significant reduction of 3.68* (CI 95%: -5.28 to -2.13). The rate for the most deprived areas went from 3.21* (CI 95% 2.27 to 4.54) times that of the most affluent areas to 2.01* (CI 95%: 1.45 to 2.87), which corresponds to a non-significant reduction in inequalities. City B: Areas in the most deprived fourth had 1.88* (CI 95%: 1.46 to 2.42) times the	The audit of measures was limited to speed humps, road narrowings, and road closures. The article does not provide information about similarities or differences between road networks in the most and least deprived areas (often the most affluent areas are already calmed, for example by grids made up of cul-de-sacs, a possibility here, given the significant differences in the length of road networks in the most and least deprived areas, particularly in city A). This article evaluates the effects of traffic-calming measures on an area including more than one road, but it does not indicate whether or not the measures were planned and implemented so as to function in a systemic manner.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Jones, Lyons, John, & Palmer, 2005) (cont.)			number of traffic-calming measures/1000 residents as those in the most affluent fourth. The personal injury collision rate did not vary significantly between 1992–1994 and 1998–2000 and inequalities were not reduced significantly, the rate for the most deprived areas having gone from 4.27* (CI 95%: 2.51 to 7.28) times that of the most affluent areas to 3.96* (CI 95%: 2.26 to 6.95). Variations in the personal injury collision rates are inversely correlated to the density of traffic-calming measures (n.b. of traffic-calming measures/km of road) (r=-0.769*, p=0.026). Similar proportions of children walked to school in both cities.	
(Kamphuis et al., 2008)	How are individual and environmental characteristics (including traffic-calming measures) associated with area socioeconomic inequalities in the Melbourne region (Australia) and between-area differences in	Design: cross-sectional study. Measurement of the practice of cycling for recreational purposes: at least once a month vs. never. Survey by postal questionnaire on cycling habits and individual characteristics (age, sex, education, occupation); 2349 participants, 2203 valid questionnaires. Environmental audits using a Geographic Information System (GIS) for some environmental characteristics (road network design	Traffic-calming measures are one of the four characteristics of road design that are significantly associated with recreational cycling (odds ratio [OR]: 2.90*, confidence interval [CI] 95%: 1.19 to 7.02). Bike paths and lanes on roads, which can be used to calm traffic, are another (OR: 5.40*, CI 95%: 1.29 to 22.60).	Bike paths and lanes can be introduced as traffic-calming measures (Macbeth, 1998). This article does not indicate why they were introduced or how they modified the road environment (e.g., by narrowing the road). Also, some traffic-calming measures (e.g., curb extensions) were classified under “safety” as “crossing aids,” which excludes them from the analysis of traffic-calming measures (considered alone, this category produces no significant association,

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Kamphuis et al., 2008) (cont.)	recreational cycling?	[includes some calming measures], safety [includes other calming measures], destinations, and aesthetics). Analysis using multilevel logistic regression.		but it could be otherwise were it combined with other characteristics classified as "calming" features). This article evaluates the effects of traffic-calming measures on an area including more than one road, but it does not indicate whether or not the measures were planned and implemented so as to function in a systemic manner.
(Owen, 2005)	What are the effects on air quality of six 20-mph (32-km/h) zones implemented in North West England?	Design: before-after study with control site. The article considered 0.5 km x 0.5 km zones with signs and traffic-calming measures that modified road design (e.g., speed humps). Concentrations of NO_2 and benzene measured before (5 to 9 months) and after (3 to 12 months) at three sites within each zone and at one outside control site. Use of diffusion tubes and thermal desorption tubes. Analysis of standard deviation and temporal variation. Vehicle emissions (NO_x and benzene) estimated on the basis of average speeds and traffic volumes. Use of a dispersion model to determine the contribution of traffic	Ambient concentrations of air pollutants measured were not significantly affected by the interventions. For the five zones for which calculations were performed, emissions per vehicle rose (0 to +5%[Ŧ] NO_x, +11 to +34%[Ŧ] benzene), but when variations in traffic volume were taken into account, emissions were shown to have decreased in the majority of zones (+8, -18, -9, -32 and -80%[Ŧ] NO_x; +22, +3, -15, -32 and -76%[Ŧ] benzene). The dispersion model indicates that the contribution of traffic within the zone to the ambient concentrations of air pollutants measured is weak (4 to 14%[Ŧ] of NO_x; 0 to 3%[Ŧ] of NO_2).	Controlled for background concentrations and weather. Controlled for traffic volumes, but use of average speeds instead of real speeds (thus eliminating the effect of speed variations). Imprecision of instruments measuring air quality (±25% for the diffusion tubes).

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Owen, 2005) (cont.)		in the zone to ambient concentrations of air pollutants.		
(Várhelyi, 2002)	What are the effects of an experimental scheme involving the installation of 21 mini-roundabouts (at intersections whose daily volume can go as high as 23,500 vehicles) in Växjö, Sweden, on gas consumption and CO and NO_x emissions?	Design: before-after. Recording of driving cycles before (n=600) and after (n=800) the installation of mini-roundabouts to construct standard driving cycles. Vehicles were selected randomly and followed by a car equipped to record distance travelled twice per second. The driver of the car with the measuring equipment copied the movements of the other drivers without their knowledge. Traffic counting performed with automatic counters and manually. Model used to calculate gas consumption and emissions.	At the 20 mini-roundabouts replacing intersections without traffic lights: significant increase in CO (+13%*) and non-significant increase in NO_x (+8%) and gas (+8%) for users of main roads, and non-significant decrease for those using secondary roads (-20% CO, -15% NO_x, -21% gas). Combined, the mini-roundabouts produced a non-significant increase in emissions (+6% CO and +4% NO_x) and gas consumption (+3%). With regard to the mini-roundabout replacing an intersection with traffic lights, non-significant reductions in emissions and gas consumption were calculated (-29% CO, -21% NO_x, -28% gas). No significant change in traffic volume.	The article points to the importance of the implementation context of interventions (e.g., is an intersection with or without traffic lights being replaced?) and the varying potential effects at intersections (main road vs. secondary road). Calculations were limited to gas-powered cars, despite the fact that heavy vehicles comprised 7% of traffic. Calculations were based on the assumption that 30% of cars were equipped with catalytic converters. Only one statistically significant result. The article does not indicate precisely when, with respect to the installation of the mini-roundabouts, the effects were measured.
(Zein, Geddes, Hemsing, & Johnson, 1997)	What effects do traffic-calming schemes have on the frequency and severity of collisions?	Design: before-after. Four areas in the Greater Vancouver and Victoria regions were examined. The interventions are described with the help of maps showing the types and locations of measures. Before-after study (the authors reviewed data for one year before the	The four interventions reduced the frequency of collisions (-40%ᵻ on average) and the annual cost of collisions (-38%ᵻ on average).These averages obscure marked differences between the interventions (for example, a stop-sign scheme in Burnaby and a scheme involving highly diverse physical measures in the West End area),	This article does not meet recognized scientific standards. In particular, it provides very little information about data sources and about the years being compared, which makes it impossible to reproduce and compare the measured reductions in general trends.

EVALUATIONS OF A SERIES OF TRAFFIC-CALMING MEASURES IMPLEMENTED WITHIN A GEOGRAPHIC AREA COMPRISING MORE THAN ONE ROAD (CONT.)

AUTHOR (YEAR)	RESEARCH QUESTION	METHODOLOGY	RESULTS	REMARKS
(Zein, Geddes, Hemsing, & Johnson, 1997) (cont.)		interventions and collected data following the intervention, but without indicating when). Indicators: collision frequency (police data) and collision severity (annual costs of insurance claims according to the Insurance Corporation of British Columbia).	significant differences between areas (for example, -18%[Ŧ] for collision frequency in West End, Vancouver, and -60%[Ŧ] in Burnaby) and between indicators (in Burnaby, -60%[Ŧ] for collision frequency and -48%[Ŧ] for claims costs).	However, the interventions are very well described and the level of detail provided in the analysis tables makes the results more informative than many studies meeting the recognized scientific standards.

BIBLIOGRAPHY

Abbott, P., Tyler, J., & Layfield, R. (1995). *Traffic calming: vehicle noise emissions alongside speed control cushions and road humps* (Report No. TRL 180). Crowthorne, Berkshire: Transport Research Laboratory.

Ahn, K. & Rakha, H. (2009). A field evaluation case study of the environmental and energy impacts of traffic calming. *Transportation Research Part D: Transport and Environment, 14,* 411-424. doi: 10.1016/j.trd.2009.01.007.

Boulter, P. G., Hickman, A. J., Latham, S., Layfield, R., Davidson, P., & Whiteman, P. (2001). *The impacts of traffic calming measures on vehicle exhaust emissions* (Report No. TRL 482). Crowthorne, Berkshire: Transport Research Laboratory.

Boulter, P. G. & Webster, D. C. (1997). *Traffic calming and vehicle emissions: A literature review* (Report No. TRL 307). Crowthorne, Berkshire: Transport Research Laboratory.

Bunn, F., Collier, T., Frost, C., Ker, K., Roberts, I., & Wentz, R. (2003). Traffic calming for the prevention of road traffic injuries: systematic review and meta-analysis. *Injury Prevention, 9,* 200-204.

Bunn, F., Collier, T., Frost, C., Ker, K., Steinbach, R., Roberts, I. & Wentz, R. (2009). Area-wide traffic calming for preventing traffic related injuries. *Cochrane Database of Systematic Reviews 2003*, *1*, 1-36. doi: 10.1002/14651858.CD003110.

Campolieti, D. & Bertoni, D. (2009). The action plan for noise reduction in Modena: methods, effects and perspectives. *Radiation Protection Dosimetry, 137*(3-4), 252-255. doi: 10.1093/rpd/ncp209.

Carver, A., Timperio, A. F., & Crawford, D. A. (2008). Neighborhood Road Environments and Physical Activity Among Youth: The CLAN Study. *Journal of Urban Health, 85*(4), 532-544. doi: 10.1007/s11524-008-9284-9.

Cloke, J., Webster, D., Boulter, P., Harris, G., Stait, R., Abbott, P. & Chinn, L. (1999). *Traffic Calming: Environmental assessment of the Leigh Park Area Safety Scheme in Havant* (Report No. TRL 397). Crowthorne, Berkshire: Transport Research Laboratory.

Cubbin, C. & Smith, G. S. (2002). Socioeconomic Inequalities in Injury: Critical Issues in Design and Analysis. *Annual Review of Public Health, 23,* 375. doi: 10.1146/annurev.publhealth.23.100901.140548.

Daham, B., Andrews, G. E., Li, H., Partridge, M., Bell, M. C., & Tate, J. (2005). *Quantifying the Effects of Traffic Calming on Emissions Using On-road Measurements* (Report No. 2005-01-1620). Warrendale, U.S.: SAE International. Retrieved from: http://eprints.whiterose.ac.uk/2050/1/2005-01-1620SOrion_peedbump.pdf.

Elvik, R. (2001). Area-wide urban traffic calming schemes: a meta-analysis of safety effects. *Accident Analysis & Prevention, 33,* 327-336.

Forsyth, A., Hearst, M., Oakes, J. M., & Schmitz, K. H. (2008). Design and Destinations: Factors Influencing Walking and Total Physical Activity. *Urban Studies, 45,* 1973-1996. doi: 10.1177/0042098008093386.

Gibbard, A., Reid, S., Mitchell, J., Lawton, B., Brown, E., & Harper, H. (2004). *The effect of road narrowings on cyclists* (Report No. TRL 621). Crowthorne, Berkshire: Transport Research Laboratory. Retrieved from: http://www.transport-research.info/Upload/Documents/200607/20060728_163846_65628_UG171_Final_Report.pdf.

Grundy, C., Steinbach, R., Edwards, P., Green, J., Armstrong, B., & Wilkinson, P. (2009). Effect of 20 mph traffic speed zones on road injuries in London, 1986-2006: controlled interrupted time series analysis. *BMJ, 339,* b4469. doi: 10.1136/bmj.b4469.

Grundy, C., Steinbach, R., Edwards, P., Wilkinson, P., & Green, J. (2008a). *The Effect of 20 mph zones on Inequalities in Road Casualties in London: A report to the London Road Safety Unit.* London: London School of Hygiene and Tropical Medicine. Retrieved from: http://www.tfl.gov.uk/assets/downloads/the-effect-of-20-mph_-zones-on-inequalities_in-road-casualties-in-london.pdf.

Grundy, C., Steinbach, R., Edwards, P., Wilkinson, P., & Green, J. (2008b). *20 mph Zones and Road Safety in London: A report to the London Road Safety Unit.* London: London School of Hygiene and Tropical Medicine. Retrieved from: http://www.20splentyforus.org.uk/UsefulReports/20-mph-zones-and-road-safety-in-london.pdf.

Hemsing, S. & Forbes, G. (2000). *Ottawa-Carleton Traffic Calming Evaluation Study* (Report No. 99041). Synectics.

Hyden, C. & Várhelyi, A. (2000). The effects on safety, time consumption and environment of large scale use of roundabouts in an urban area: a case study. *Accident Analysis & Prevention, 32,* 11-23.

Jones, S. J., Lyons, R. A., John, A., & Palmer, S. R. (2005). Traffic calming policy can reduce inequalities in child pedestrian injuries: database study. *Injury Prevention, 11,* 152-156. doi: 10.1136/ip.2004.007252.

Kamphuis, C. B. M., Giskes, K., Kavanagh, A. M., Thornton, L. E., Thomas, L. R., van Lenthe, F. J., Turrel, G. (2008). Area variation in recreational cycling in Melbourne: a compositional or contextual effect? *Journal of Epidemiology and Community Health, 62,* 890-898. doi: 10.1136/jech.2007.067116.

Laflamme, L., Hasselberg, M., & Burrows, S. (2010). 20 Years of Research on Socioeconomic Inequality and Children's Unintentional Injuries – Understanding the Cause-Specific Evidence at Hand. *International Journal of Pediatrics,* 1-23. doi: 10.1155/2010/819687.

Macbeth, A. (1998). *Calming Arterials in Toronto*. Conference proceedings. "68th Annual Meeting of the Institute of Transportation Engineers". Toronto, Ontario, August 9-12, 1998. Retrieved from: http://www.ite.org/traffic/documents/AHA98C19.pdf.

Morency, P. & Cloutier, M.-S. (2005). *Distribution géographique des blessés de la route sur l'île de Montréal (1999-2003). Cartographie pour les 27 arrondissements.* Direction de santé publique. Agence de développement de réseaux locaux de services de santé et de services sociaux de Montréal. Retrieved from: http://publications.santemontreal.qc.ca/uploads/tx_asssmpublications/2-89494-460-8.pdf.

Morrison, D. S., Thomson, H., & Petticrew, M. (2004). Evaluation of the health effects of a neighbourhood traffic calming scheme. *Journal of Epidemiology and Community Health, 58,* 837-840. doi: 10.1136/jech.2003.017509.

Mountain, L. J., Hirst, W. M., & Maher, M. J. (2005). Are speed enforcement cameras more effective than other speed management measures? An evaluation of the relationship between speed and accident reductions. *Accident Analysis & Prevention, 37,* 731-741. doi: 10.1016/j.aap.2005.03.017.

Owen, B. (2005). Air quality impacts of speed-restriction zones for road traffic. *Science of The Total Environment, 340,* 13-22. doi: 10.1016/j.scitotenv.2004.08.011.

Retting, R. A., Bhagwant, P. N., Garder, P. E., & Lord, D. (2001). Crash and Injury Reduction Following Installation of Roundabouts in the United States. *American Journal of Public Health, 91*(4)*,* 628-631.

Stout, T. B., Pawlovich, M., Souleyrette, R. R., & Carriquiry, A. (2006). Safety impacts of "road diets" in Iowa. *Institute of Transportation Engineers. ITE Journal*, *76*, 24-27.

Tester, J. M., Rutherford, G. W., Wald, Z., & Rutherford, M. W. (2004). A Matched Case-Control Study Evaluating the Effectiveness of Speed Humps in Reducing Child Pedestrian Injuries*. American Journal of Public Health*, *94*(4), 646-650.

Várhelyi, A. (2002). The effects of small roundabouts on emissions and fuel consumption: a case study. *Transportation Research Part D, 7,* 65-71.

Watkins, K. F. (2000). *Cambridge's Traffic Calming Program: Pedestrians are the Focus.* Conference proceedings. “ITE 2000 Annual Meeting and Exhibit” Nashville, Tennessee August 6-8, 2000. Retrieved from: http://www.ite.org/traffic/documents/AB00H3702.pdf.

Zein, S. R., Geddes, E., Hemsing, S., & Johnson, M. (1997). Safety Benefits of Traffic Calming. *Transportation Research Record, 1578*(1)*,* 3-10. doi: 10.3141/1578-01.

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