Urban Traffic Calming and Health Inequalities: Effects and Implications for Practice

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Summary

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This document is the final one in a series of five documents based on a literature review published in 2011.[1] The four previous documents compared the effects of two approaches to urban traffic calming[2] – the black-spots approach and the area-wide approach – on four determinants of health: road safety, air quality, environmental noise and active transportation. In this document, we will examine the effects of these same two approaches (described below) on health inequalities. This will enable us to identify interventions that can effectively improve population health, overall, while also reducing health inequalities. Such interventions will be distinguished from those which act on only one or the other of these dimensions.

We will begin with a brief discussion of how health inequalities are conceptualized, followed by a few Canadian examples of health inequalities associated with, among other things, past and current transportation policies. This will be followed by a summary of the results of studies having evaluated the two approaches to traffic calming, focusing on the effects of these two approaches on various health inequalities. We will weigh the implications of these results for public health actors and, finally, present an analysis grid that can help public health actors to anticipate the effects of traffic-calming interventions on health inequalities.

How are health inequalities conceptualized?

In public health generally, as well as in the literature on the effects of transportation policies in particular, the terms “disparity,” “inequality” and “inequity” are frequently used to compare the health status of different populations or the effects of policies, programs or interventions on different groups of individuals. Some authors use these terms synonymously to refer to systemic, avoidable and unfair differences that, for ethical or moral reasons, we must attempt to reduce or eliminate (e.g., Whitehead & Dahlgren, 2006). Other authors use one or several of these terms (“disparity” and/or “inequality”) descriptively and restrict normative use to other terms (“inequalities” and/or “inequity”) (e.g., Hayward & Colman, 2003; Kawachi, Subramanian, & Almeida-Filho, 2002). When used descriptively, these terms can refer to a situation or effect characterized by differences in health status, without any ethical or moral judgement necessarily being attached to these differences, whereas this judgement is integral to the normative use of the terms. In this text, we will exclusively use the term “inequality” and it will be used descriptively.

Regardless of the vocabulary used, the identification of health inequalities requires, at least, that a population be divided into sub-groups and that these be compared on the basis of health status or of a health determinant. In other words, it is necessary to know *who* is being compared to *whom, and on what basis.*[3] In the literature on the effects of transportation policies, many variables have been combined and cross-referenced in efforts to identify inequalities between different groups of people. Table 1 lists a few of the most frequently used of these variables (e.g., Evans & Brown, 2003; Litman, 2012; Sanchez, Stolz, & Ma, 2003).

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1 To consult the comprehensive version of the literature review, please see our document entitled *Urban Traffic Calming and Health: A Literature Review,* available at: http://www.ncchpp.ca/175/publications.ccnpps?id_article=686

2 Our definition of “traffic calming” is presented in the introduction to our literature review, and its historical origins are detailed in our document entitled *Traffic Calming: An Equivocal Concept*, available at: http://www.ncchpp.ca/175/publications.ccnpps?id_article=648

3 How the basic divisions of *who* and *what* are drawn and the way these elements are combined and cross-referenced, allows discussion of health inequalities to be focused on different issues and facets of inequality (the gap between the most and least advantaged, the social gradient of least to most advantaged, etc.). This makes it possible to consider different ways of understanding the emergence and development of these inequalities and to develop ways of acting on them. There is a significant body of literature on each of these aspects, whose exploration greatly extends beyond the scope of this briefing note.

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Table 1: Variables frequently used to discuss health inequalities associated with transportation policies

Who?	What?
• Socioeconomic status (SES) • Income • Race/Ethnicity • Place of residence • Mode of travel • Level of education • Occupation • Gender • ...	• Access to services, employment etc. • Rates of collision, injury and death • Exposure to noise • Exposure to air pollutants • Amount of physical activity • Number of trips made using active transportation • Perceived safety • Presence (or quality) of infrastructure • ...

Canadian examples of inequalities associated with transportation policies

Many studies have assessed the range of health inequalities that can be associated, in particular, with policies that influence the distribution of automobile traffic volumes and speeds in Canada. The Canadian Institute for Health Information (CIHI), for example, has divided the Canadian population and that of several Census Metropolitan Areas (CMAs) in the country, including that of the Edmonton CMA, into three categories of socioeconomic status (SES) and compared their rates of hospitalization linked to road collisions. The study in question (CIHI, 2008) revealed an unequal distribution of these rates: the lower a group's SES, the higher its rate of hospitalization linked to road collisions (see Figure 1).

Collisions, along with the resulting injuries and deaths, are not the only effects distributed unequally within the population that can be associated with transportation policies. Air and noise pollution associated with motor vehicle traffic constitute two more examples, among others. In another CIHI report (2011), the Canadian population was categorized, this time according to household income and place of residence (rural or urban), to compare the percentage of individuals in each of these groups who perceived their neighbourhood as being too noisy or polluted.

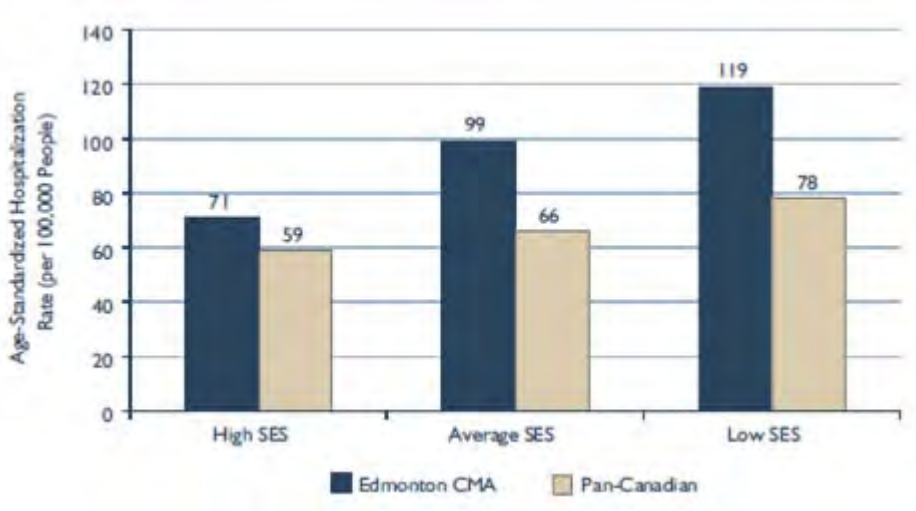

Figure 1: Unequal distribution of hospitalization rates linked to road collision by SES

Source: CIHI, 2008, p. 46.

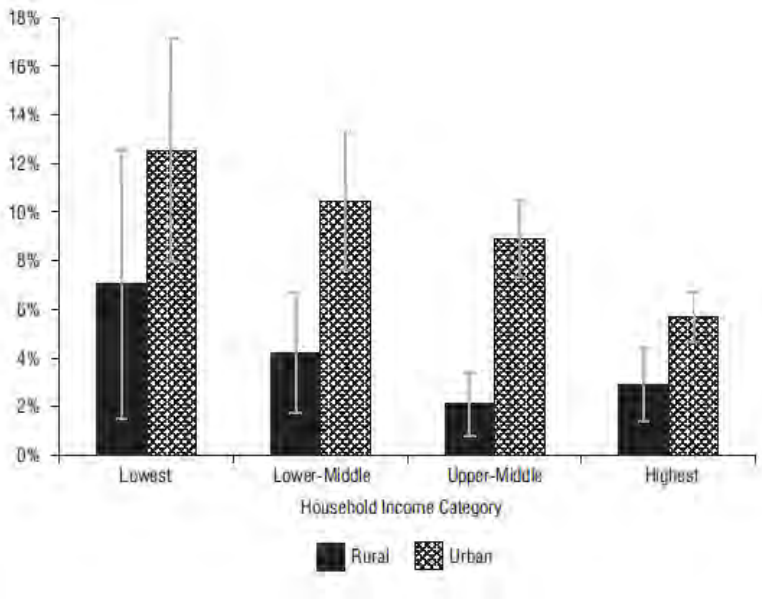

Figure 2: Unequal distribution of percentage of adults who perceive their neighbourhood to be too noisy or polluted, by household income and place of residence (urban/rural)

Source of data: National Population Health Survey, 2006-2007, Statistics Canada.
Source of figure: CIHI, 2011, p. 11.

As Figure 2 shows, in general, the lower a household's income in urban areas, the more likely are its members to perceive their neighbourhood as being too noisy or polluted. This figure also shows that a higher proportion of urban households than rural households consider noise or air pollution to be an annoyance.

These two Canadian examples not only illustrate some of the ways health inequalities can be framed, they also demonstrate the current existence of health inequalities in Canada that can be associated, at least in part, with the effects of past and current transportation policies. These policies partly determine certain factors that can explain these inequalities, such as the volume of traffic in a region and its distribution among different sectors and roads, the speed of this traffic within sectors and on roads, the design of roads and road networks, etc. Traffic-calming policies are one means, among others, of influencing these factors, particularly in urban centres that are already largely built up. In theory, traffic calming can thus be used to reduce certain health inequalities, particularly in these urban settings.

Results of evaluative studies

For our literature review, we searched for and synthesized studies focusing on the effects of traffic calming in urban settings. In doing so, we differentiated between interventions based on a black-spots approach and those based on an area-wide approach.[4] The text box below summarizes the main differences between these two approaches.

Two approaches to traffic calming

The black-spots approach is typically aimed at improving road safety. It encompasses strategies advocating the installation of traffic-calming measures (speed humps, roundabouts, etc.) at one or more specific locations considered to be at high risk for collision.

The area-wide approach, while it also often includes road-safety objectives, aims more generally to improve the living environment. It encompasses intervention strategies whose scope of application is a network comprising more than one road.

[4] For a detailed description of the two approaches and the political contexts surrounding them, please see our document entitled *Traffic Calming: Political Dimensions*, available at: http://www.ncchpp.ca/175/publications.ccnpps?id_article=670

The results of evaluative studies have been categorized according to these two approaches to highlight their respective effects on various health inequalities.

Effects of the black-spots approach

COLLISIONS, INJURIES AND DEATHS

Four out of the fourteen studies consulted that had evaluated isolated interventions examined the main intended effects of the black-spots approach, namely reductions in collisions, injuries and deaths (Bellefleur & Gagnon, 2011). All of these studies reported substantial reductions in collisions, injuries and deaths in the calmed areas (Retting, Bhagwant, Garder, & Lord, 2001; Stout, Pawlovich, Souleyrette, & Carriquiry, 2006; Mountain, Hirst, & Maher, 2005; Tester, Rutherford, Wald, & Rutherford, 2004). For example, reductions in personal injury collisions can be as high as between 74% and 77% following the installation of single-lane roundabouts (Retting et al., 2001). However, none of these studies was designed to evaluate the effects of these reductions on health inequalities in urban settings.

AIR QUALITY, NOISE AND ACTIVE TRANSPORTATION

Among the studies consulted, those that examined the effects on the other determinants of health covered by the literature review indicate that isolated traffic-calming interventions:

- Tend to produce an increase in pollutant emissions at the calmed sites (Boulter & Webster, 1997; Boulter et al., 2001; Daham I., 2005; Ahn & Rakha, 2009), with the exception of interventions that decrease speed variations at the same time as travelling speeds (e.g., mini-roundabouts) (Ahn & Rakha, 2009);
- Tend to decrease noise made by cars and increase that made by trucks. In the latter case, noise levels increase, in particular, when trucks travel over traffic-calming measures with vertical deflections (e.g., speed humps) (Abbott et al., 1995; Campolieti & Bertoni, 2009);
- May be accompanied by an increase in active travel (Morrison, Thomson, & Petticrew, 2004) and an overall improvement in the perceived safety of drivers, pedestrians and cyclists (Watkins, 2000; Morrison et al., 2004). However, cyclists, and particularly women cyclists, tend to feel less safe in the presence of traffic-calming measures that force them closer to motorized traffic (e.g., road narrowings that are not designed with cyclists in mind) (Gibbard et al., 2004).

Among these studies, only the last one (Gibbard et al., 2004) was designed to measure the potentially unequal distribution of an effect (perceived safety) on different segments of the population (men/women).

Effects of the area-wide approach

COLLISIONS, INJURIES AND DEATHS

Although area-wide traffic-calming schemes are often promoted as a way to improve the overall living environment in urban settings, the majority of studies, that is, ten out of the seventeen consulted, focused on the effects of area-wide interventions on collisions, injuries and deaths (Bunn et al., 2003 and 2009; Cloke et al., 1999; Elvik, 2001; Grundy, Steinbach, Edwards, Wilkinson, & Green, 2008a and 2008b; Grundy et al., 2009; Hyden & Várhelyi, 2000; Jones, Lyons, John, & Palmer, 2005, Zein et al., 1997). Only two of these studies also evaluated other dimensions (Cloke et al., 1999; Hyden & Várhelyi, 2000). These ten studies, overall, report significant reductions in collisions, injuries and deaths among all road users (e.g., pedestrians, cyclists, drivers, etc.) on all roads within calmed networks and even on adjacent roads (Bellefleur & Gagnon, 2011). Some of these studies also examined the effects of these interventions on different groups within the population, namely:

- Different road users (pedestrians, cyclists, drivers or passengers and motorcyclists);
- Children and the general population;
- Sectors with different SESs;
- Persons identified as white, black or Asian.[5]

Road users

One study (Grundy et al., 2008a) reported that in the 399 20-mph (32-km/h) zones in London the reduction in personal injury collisions and collisions with persons killed or seriously injured was greater

[5] The researchers used the terms “Black,” “White,” “Asian” and “Other” to reflect the “police-assigned ‘ethnicity’ code from the STATS19” (Grundy et al., 2008b, p. 10), the form used by the London police to describe collisions. Despite our reservations regarding the use of these terms, we do not wish to ignore evidence of inequalities tied to these categories based on perceptions of race. For this reason, we have reproduced them as they appear.

for drivers and passengers than for other users.[6] It is worth noting that cyclists benefited the least from the reduction in collisions associated with these zones. Another study (Hyden & Várhelyi, 2000) estimated that a scheme involving the installation of 21 mini-roundabouts substantially reduced the risk of personal injury collisions involving pedestrians (-80%) and cyclists (-60%) without either increasing or decreasing the risk for drivers and passengers.

Children and the general population

The 399 20-mph (32-km/h) zones also protected more children (0-15 years old), whether they were pedestrians, cyclists or in another category, than members of the overall population[7] (Grundy et al., 2008a).

Sectors with different SESs

In general, these same 20-mph (32-km/h) zones proved equally effective (in terms of percentages) at reducing personal injury collisions and collisions with persons killed or seriously injured, regardless of the SES of the sector in which they were implemented (Grundy et al., 2008b). It is believed that a policy which prioritized implementing the 20-mph (32-km/h) zones in the most socioeconomically disadvantaged sectors reduced the widening of the gap between the number of personal injury collisions in the most and least disadvantaged sectors by about 15% between 1987 and 2006 (Grundy et al., 2008b). In other words, inequalities increased in London between 1987 and 2006, but they increased less than they would have without this policy. Another study (Jones et al., 2005) indicates that the implementation of area-wide traffic-calming strategies in sectors with a low SES leads to a reduction, within cities, of the gap in the rate of young pedestrians (4-16 years old) injured between sectors with different SESs.

Persons identified as white, black or Asian

One study shows that the 20-mph (32-km/h) zones implemented in London seem, in general, to better protect persons identified as white than those identified as black or Asian (Grundy et al., 2008b), but the study in question does not provide an explanation for these differences.

AIR QUALITY, NOISE AND ACTIVE TRANSPORTATION

Some studies also examined the broader issue of the effects of area-wide traffic-calming strategies on the living environment and habits of residents. They report that, in general, area-wide strategies:

- Have variable effects on the amount of particulate matter emitted per vehicle in calmed sectors (Boulter & Webster, 1997; Cloke et al., 1999; Owen, 2005; Várhelyi, 2002). These effects, however, are not sufficient to significantly affect ambient air quality (Cloke et al. 1999; Owen, 2005);
- Tend to decrease noise from automobiles (Cloke et al., 1999; Hyden & Várhelyi, 2000) and increase noise from trucks when truck drivers must slow down and accelerate to travel over traffic-calming measures (e.g., speed humps) (Cloke et al., 1999);
- Increase the perceived safety of pedestrians and children, but decrease that of cyclists when they are forced closer to moving vehicles (Hemsing & Forbes, 2000; Cloke et al., 1999);
- Have an uncertain effect on active transportation (Forsyth, Hearst, Oakes, & Schmitz, 2008; Carver, Timperio, & Crawford, 2008; Cloke et al., 1999) and levels of physical activity (Carver et al., 2008; Forsyth et al., 2008), with the exception of strategies that include cycle tracks and bike lanes, which seem to encourage bicycle travel (Kamphuis et al., 2008).

Of these studies, only one (Hemsing & Forbes, 2000) was designed to measure the potentially unequal distribution of an effect (perceived safety) on different segments of the population (pedestrians, cyclists and children).

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[6] Drivers and passengers: -52.5% personal injury collisions (PICs) and -61.8% collisions with persons killed or seriously injured (KSI); pedestrians: -32.4% PICs and -34.8% KSI collisions; cyclists: -16.9% PICs and -37.6% KSI collisions; motorcyclists: -32.6% PICs and -39.1% KSI collisions (Grundy et al., 2008a).

[7] Children pedestrians: -46.2% PICs and -43.9% KSI collisions, compared to -32.4% PICs and -34.8% KSI collisions for the overall population; children cyclists: -27.7% PICs compared to -16.9% PICs for the overall population; all modes of travel combined, for children: -48.5% PICs and -50.2% KSI collisions, compared to -41.9% PICs and -46.3% KSI collisions for the overall population (Grundy et al., 2008a).

Implications for practice

THE BLACK-SPOTS APPROACH

Despite the absence of evaluations of the effects of the black-spots approach on inequalities in the rates of **collision, injury and death between** different SES or income groups, this approach seems *a priori* promising as a way to reduce these inequalities. In fact, studies have shown that the number of personal injury collisions tends to be higher in the lower-income sectors of cities, as well as in the sectors with the lowest SES indicators (Grundy et al., 2008b; Hamel & Pampalon, 2002). The intersections with the highest risk of collision also tend to be located in the lower-income sectors, along with road segments with high traffic volumes and speeds (Lewis, 1997; Morency, Gauvin, Plante, Fournier, & Morency, 2012). Many studies have also shown that the poorest segments of the population and those with the lowest SES indicators often suffer a disproportionate amount of road injuries and deaths in urban settings (Cubbin & Smith, 2002; CIHI, 2008; Laflamme, Hasselberg, & Burrows, 2010; World Health Organization, 2004). Thus, it is relevant that traffic-calming strategies based on the black-spots approach target, by definition, the locations with the highest risk of collisions in a given territory. *By its very logic, the black-spots approach should target more sites in less advantaged sectors and thus help reduce inequalities in road injuries and deaths between different SES and income groups. Clearly, public health actors concerned with this objective can promote policies that prioritize black-spots traffic-calming measures in less advantaged sectors.*[8]

It seems unlikely that the black-spots approach can be used to significantly and variably influence the exposure of populations to **air pollution** and **noise pollution** caused by motorized traffic, because, unlike the area-wide approach, the black-spots approach leads to targeted interventions at one or more isolated points in the road network and not to the intensive installation of traffic-calming measures in one or more areas. For the same reason, it is unlikely that the black-spots approach can be used to significantly reduce health inequalities associated with **active transportation**, except in rare cases where a road network is already generally conducive to walking and cycling and where isolated interventions in high-risk and problem spots would make the network as a whole conducive to active transportation.

However, since perceived danger linked to motorized traffic is a major dissuading factor for **cycling** in general (Jacobsen, Racioppi, & Rutter, 2009; Pucher & Buehler, 2008; Pucher, Dill, & Handy, 2010; Pucher, Garrard, & Greaves, 2011; Reynolds, Harris, Teschke, Cripton, & Winters, 2009), and for cycling by children, seniors and women, in particular (Jacobsen, 2003; Pucher & Buehler, 2008; Pucher et al., 2011), the use of traffic-calming measures that force cyclists closer to motorized traffic can contribute to an increase in health inequalities associated with active transportation. *To avoid discouraging cycling in general and to avoid more greatly discouraging women, children and seniors from cycling, public health actors concerned about this type of inequality may therefore consider it relevant to promote traffic-calming measures that do not force cyclists closer to motorized traffic.* In fact, it is often possible to adapt traffic-calming measures, so that they have the same effect on motorized traffic without inconveniencing cyclists (for an example, see Figure 3).

THE AREA-WIDE APPROACH

Regarding studies that have evaluated the area-wide approach, these mainly demonstrate that area-wide traffic-calming strategies can help reduce health inequalities in **collisions, injuries and deaths** between sectors with different SESs when they are implemented in less advantaged sectors. Moreover, since collisions, injuries and deaths generally occur more frequently in less advantaged sectors, and since area-wide strategies are equally effective (in terms of percentages) regardless of the SES of the sector in which they are implemented, targeting less advantaged sectors for the implementation of area-wide traffic-calming strategies should also make it possible to prevent more collisions, injuries and deaths than if these strategies were implemented in more advantaged sectors. *Public health actors concerned by these inequalities can thus promote the implementation of area-wide strategies in low-SES sectors to 1) prevent the maximum number of*

[8] The two broad objectives of public health, which are the reduction of health inequalities and the improvement of overall population health, can converge or diverge. With respect to the reduction of road injuries, the black-spots approach lends itself to a convergence of these two objectives. However, there will always be exceptions that will prompt public health actors to take a stance that puts more emphasis either on improving population health (e.g., prioritizing the most at-risk sites) or on reducing inequalities (e.g., prioritizing the most at-risk sites in the least advantaged sectors).

Figure 3: Two road narrowings configured differently

The choker on the left forces cyclists closer to moving vehicles, but the one on the right does not.
Sources: On the left, http://goo.gl/De07G. Photographer: freewheeler.
On the right, www.flickr.com. Photographer: Greg Raisman.

collisions, injuries and deaths; and 2) reduce inequalities in collisions, injuries and deaths between sectors with different SESs.

The evaluative studies also indicate that the area-wide approach tends to protect **children** more than the overall population and cyclists less than other road users. Finally, for unknown reasons, it seems that area-wide interventions better protect persons identified as white than those identified as black or Asian. Other studies would be needed to explain this last result and to clarify how it can be taken into account in practice to avoid increasing health inequalities between different **racial or ethnic groups**.

To our knowledge, there are no evaluations of the effects of the area-wide approach on inequalities in exposure to **air and noise pollution**. Nevertheless, it is likely that area-wide interventions that reduce traffic volumes as well as speeds and speed variations can help reduce certain existing health inequalities. In fact, since such interventions constitute a promising way to reduce air and noise pollution, their implementation in low-SES sectors should make it possible to reduce the often more significant presence of these irritants in these sectors.

The evaluative studies consulted were inconclusive regarding the effects of these strategies on active transportation and physical activity. This is despite the fact that area-wide traffic-calming strategies are systematically included among the interventions implemented in cities that have succeeded in increasing the modal share of **active transportation** (Pucher et al., 2010) and that the mechanisms of action underlying the area-wide approach make it a promising strategy for encouraging active travel (Bellefleur & Gagnon, 2011). It remains possible that the implementation of area-wide strategies that take into account the needs of pedestrians and cyclists in low-SES sectors, where the infrastructure supporting active transportation is deficient, could reduce health inequalities, but this has yet to be demonstrated by evaluative research.

WHAT IS THE MOST PROMISING TYPE OF INTERVENTION?

For public health actors who consider it relevant to promote traffic calming within their territory and whose work context makes the implementation of black-spots or area-wide strategies possible, the type of intervention that seems to have the greatest potential for improving population health and reducing health inequalities:

- Is based on the area-wide approach;
- Aims to reduce speeds and speed variations;
- Aims to reduce traffic volumes;
- Is implemented in low-SES or low-income sectors;
- Is designed to take into account the needs of all users and, in particular, those of cyclists.

This said, it is important to be alert to the possibility of **traffic diversions** caused by traffic-calming strategies. These can accentuate health inequalities. In fact, the traffic-calming of an intersection, road or

area can have the effect (intended or unintended) of diverting traffic toward other roads or sectors in the city, at the risk of simply displacing the problems being addressed. Area-wide traffic-calming strategies, in particular, often explicitly aim to redirect a portion of traffic on local streets toward the arterial network (Gagnon & Bellefleur, 2011a). However, persons with a low SES are often overrepresented among residents living close to main traffic arteries. These persons therefore are already subjected to a large portion of the negative effects of motorized traffic (Smargiassi, Berrada, Fortier, & Kosatsky, 2006). *Public health actors concerned by health inequalities should thus be alert to potential traffic diversions and be aware of measures that can be implemented to prevent such diversions from accentuating health inequalities (e.g., noise abatement walls, increased safety on arteries, diversion of traffic toward arteries far removed from the population, etc.).* In this regard, it is worth noting that area-wide traffic-calming strategies do not tend to shift collisions, injuries and deaths onto arteries and roads adjacent to the intervention sector, but rather to help reduce them on these roads as well (Elvik, 2001; Grundy et al., 2008a).

An analysis grid

The analysis grid below (Table 2) can assist public health actors in anticipating the effects of traffic-calming interventions on health inequalities. The questions in the grid invite reflection on the distribution within the population of the positive and negative effects of planned traffic-calming strategies. The grid prompts users for details of the positive and negative effects anticipated, not only at intervention sites, but also on roads where a portion of traffic could be diverted. The literature review and the five information briefs we have produced should be of use in completing this step. Next, the analysis grid invites reflection concerning the populations that will benefit from the positive effects and those that will be subjected to the negative effects anticipated.

To this analysis grid, initially seen as static, we propose adding a **temporal dimension** which, while it may complicate the analysis, is essential to trying to anticipate medium- and long-term effects. It is relevant, for example, to try to anticipate how traffic patterns will evolve in the short, medium and long term, as well as how modal shares will evolve. Area-wide traffic-calming interventions are often part of global strategies for revitalizing central neighbourhoods (Gagnon & Bellefleur, 2011b). For this reason, when one of the objectives is to improve the living conditions of the socioeconomically deprived populations living in these neighbourhoods, it is particularly important to reflect on the potential movement of these populations in the medium and long term. This type of question can, for example, broaden reflection to include rent-control policies, social housing policies, etc., as part of a global strategy for reducing health inequalities.

Table 2: An analysis grid for anticipating the effects of interventions on health inequalities

	… close to the intervention?	**… where a portion of the traffic could be diverted?**
What are the anticipated effects of the intervention on the main determinants of health…	Positive effects: Negative effects:	Positive effects: Negative effects:
Who lives, works, studies, etc., ...	Who will benefit? Who will bear the brunt?	Who will benefit? Who will bear the brunt?
Who travels using what mode of transportation (car, bicycle, walking, etc.)...	Who will benefit? Who will bear the brunt?	Who will benefit? Who will bear the brunt?

Conclusion

Both approaches to traffic calming show promise as a way to reduce certain health inequalities in urban settings. However, they must be planned with this objective in mind, failing which they can also accentuate certain health inequalities. The information contained in this brief, as well as the proposed analysis grid, is intended to support public health actors who wish to promote one of these approaches to traffic calming as a way to attain the above objective, or who are called on to comment on a traffic-calming policy or plan.

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